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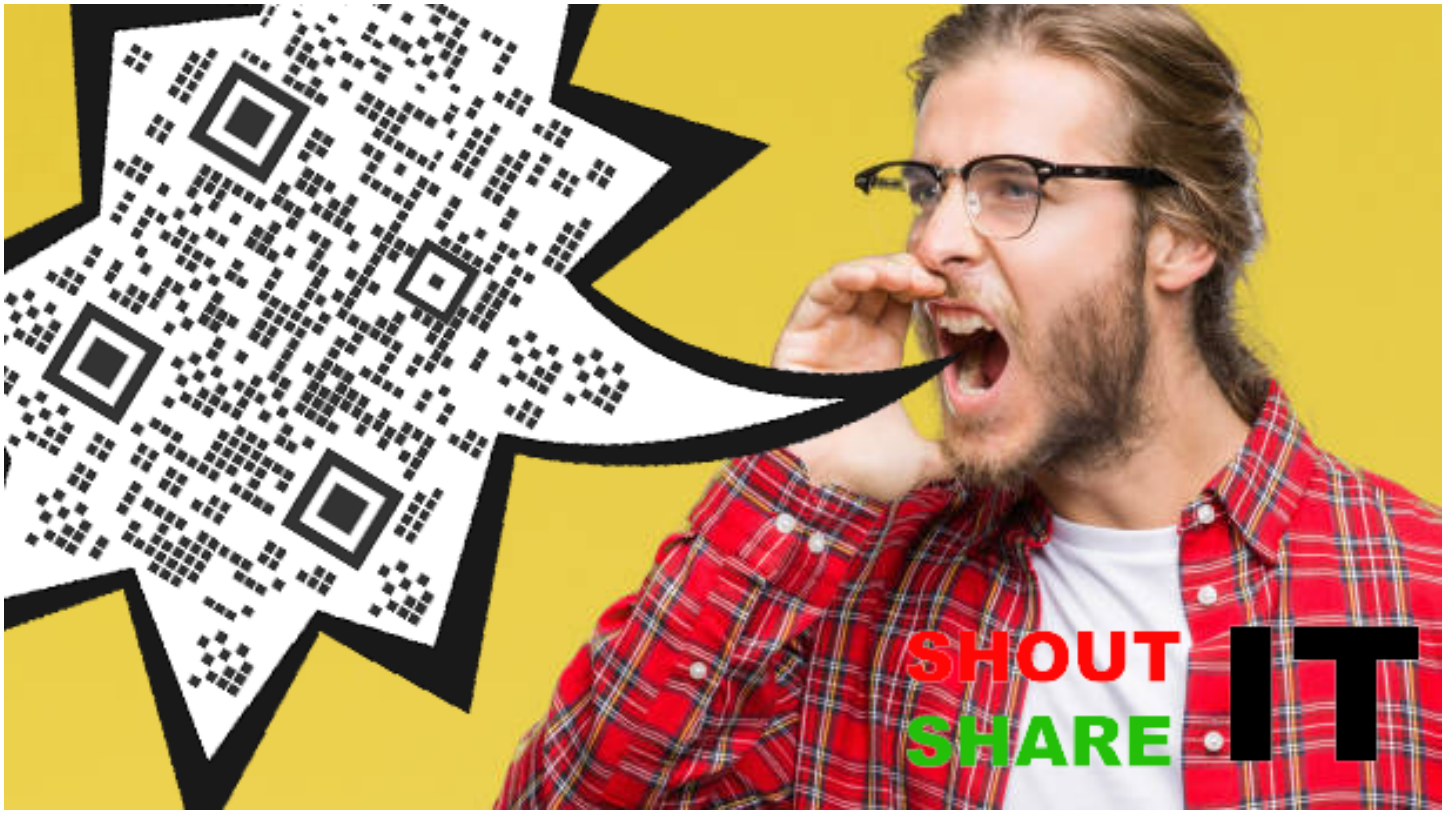
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U. S. DEPARTMENT OF AGRICULTURE,

DIVISION OF ENTOMOLOGY—BULLETIN NO. 37, NEW SERIES.

L. O. HOWARD, Chief of Division.

PROCEEDINGS

OF THE

FOURTEENTH ANNUAL MEETING

OF THE

ASSOCIATION OF ECONOMIC ENTOMOLOGISTS.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1902.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Entomology,
Washington, October 3, 1902.

Sir: I have the honor to transmit herewith the manuscript of the Proceedings of the Fourteenth Annual Meeting of the Association of Economic Entomologists, which was held at Pittsburg, Pa., June 27 and 28, 1902. The papers presented at these meetings are always of the highest economic importance, and the present series is of an unusually practical nature. The Department of Agriculture has hitherto published the secretary's reports as bulletins of this Division, and I therefore recommend the publication of the manuscript here presented as Bulletin No. 37 (new series).

Respectfully,

L. O. Howard,
Entomologist.

Hon. James Wilson,
Secretary of Agriculture.

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FOURTEENTH ANNUAL MEETING OF THE ASSOCIATION OF ECONOMIC ENTOMOLOGISTS.

MORNING SESSION, FRIDAY, JUNE 27, 1902.

The Association met in the west room of the Carnegie Lecture Hall, Carnegie Institute, Schenley Park, Pittsburg, Pa., at 10 a. m., June 27, 1902.

The following were in attendance at the sessions:

E. E. Bogue, Columbus, Ohio; A. F. Burgess, Columbus, Ohio; E. P. Felt, Albany, N. Y.; G. E. Fisher, London, Ontario; W. J. Holland, Pittsburg Pa.; A. D. Hopkins, Morgantown, W. Va.; L. O. Howard, Washington, D. C.; A. H. Kirkland, Boston, Mass.; William Lochhead, Guelph, Ontario; C. L. Marlatt, Washington, D. C.; Herbert Osborn, Columbus, Ohio; A. L. Quaintance, College Park, Md.; W. E. Rumsey, Morgantown, W. Va.; E. Dwight Sanderson, Newark, Del.; W. M. Scott, Atlanta, Ga.; J. B. Smith, New Brunswick, N. J.; F. M. Webster, Urbana, Ill.

The meeting was called to order by President A. D. Hopkins, who, after calling Mr. E. P. Felt to the chair, delivered his annual address, which follows:

ON THE STUDY OF FOREST ENTOMOLOGY IN AMERICA.

By A. D. Hopkins, *Morgantown, W. Va.*

In former addresses by presidents of this Association, many different phases of the subject of economic entomology have been discussed. A review of these twelve addresses would be interesting and valuable as a reminder of the many good things presented in each. Even a list of the titles will be suggestive of the field covered, and remind those of us who had the pleasure of hearing the addresses of their striking features and the individual characteristics and special lines of thought and work of the authors:

First. The Outlook of Applied Entomology, by C. V. Riley. Champaign, Ill. 1890.

Second. Economic Entomology, by James Fletcher. Washington, D. C. 1891.

Third. Work of the year in Economic Entomology, by S. A. Forbes (first vice-president). Rochester, N. Y. 1892.

Fourth. The Drift and Balance of our Progress for the Year, by S. A. Forbes. Madison, Wis. 1893.

Fifth. A Brief Account of the Rise and Present Condition of Applied Economic Entomology, by L. O. Howard. Brooklyn, N. Y. 1894.

Sixth. Entomological Notes and Problems, by J. B. Smith. Springfield, Mass. 1895.

Seventh. The Evolution of Economic Entomology, by C. H. Fernald. Buffalo, N. Y. 1896.

Eighth. The Present and Future of Applied Entomology in America, by F. M. Webster. Detroit, Mich. 1897.

Ninth. The Duty of Economic Entomology, by H. Osborn. Boston, Mass. 1898.

Tenth. The *Laissez-faire* Philosophy Applied to the Insect Problem, by C. L. Marlatt. Columbus, Ohio. 1899.

Eleventh. Objects of the Association of Economic Entomology, by C. P. Gillette (first vice-president). New York. 1901.

Twelfth. Life History Studies on the Codling Moth, by C. P. Gillette. Denver, Colo. 1902.

For this, the thirteenth address and fourteenth meeting, the subject of Forest Entomology in America has been chosen for at least two reasons: (1) It deals with a different phase of the science, and (2) it is a subject which will be taken up as a special feature of the work of the Division of Entomology, United States Department of Agriculture, after July 1, 1902.

The primary object will be to discuss some features of the study of forest insects in America in a way which may be of service to the student and young investigator, rather than to attempt to consider the deeper problems for those of you who are already specialists in other branches of entomology.

While forest entomology has received more attention in some European countries, especially Germany, than has any other branch of the science—and forest officials there are required to have special training in the study of insect enemies and methods of combating them—it has been comparatively neglected in America. Indeed, it has only been within recent years that a sufficient need has been recognized to justify giving it special attention. Great monumental works like those of Ratzeburg of Germany, published in 1839–1844, together with the rapid advancement at that time in systematic forest management and government control of forests throughout Europe, inspired a great interest in the subject, and led to a realization of the practical importance of a knowledge of insect enemies of trees in the successful management and protection of the forests. Therefore a knowledge of forest entomology was early recognized in Germany as one of the important features in the training of forest students and forest offi-

cials. Other important contributions followed those of Ratzeburg until there is a mass of published data which is invaluable to the foresters of Europe. But these contributions, valuable as they are to the forest interests of the older countries with long established forestry systems, relate to conditions very different from those prevailing in America. Indeed, they are valuable only to the advanced student and investigator in this country, and are not valuable or specially useful to our young students, foresters, and managers of private estate. In the aggregate there has been much original and compiled matter published in the United States relating to the insects of forest and shade trees, notably by Harris, Fitch, Walsh, Riley, LeConte, LeBaron, Saunders, Lintner, Packard, and others. Within recent years considerable additional matter has been contributed by official entomologists, but up to the present time we have nothing in the line of special instructions in the study of forest entomology that is adapted to present conditions and needs in this country.

The fifth report of the United States Entomological Commission on Forest and Shade Tree Insects is the only important attempt at a general discussion of the subject. This, as stated by the author, was "designed merely to give to the public, especially those persons interested in forestry and the planting and cultivation of shade trees, a brief summary of what is known [up to January, 1888] of the habits and appearance of such insects as are injurious to the most useful kinds of trees."

This work served a most excellent purpose by bringing together in one volume the principal records of observations of forest insects by American entomologists, and has doubtless stimulated others, as it did the present writer, to an active interest in the subject of insect enemies of trees. But it would seem that there is at present a special need of an introduction or guide to the study of forest entomology for the special use of students in forest schools and others who desire general nontechnical information on the subject.

It is, therefore, my object in this address, like the pioneer making a preliminary survey in a new country, to consider the general features of the subject and leave the details to be treated in succeeding contributions as the evolution of the forestry movement in this country indicates the need.

FORESTRY AND FOREST PROBLEMS.

Forestry, which relates to the investigation of forest problems and the management of forests with a view to utilizing their products and perpetuating their resources and beneficial influences, is becoming recognized as a branch of applied science which involves some of the greater economic problems of this country

It is made a feature of recent messages of Presidents of the United States and governors of some of the principal States. It is the subject of exhaustive Federal and State legislation. Large sums of money are annually appropriated for the establishment and maintenance of National and State forest reserves and parks, and for special research in many branches of science which have a direct bearing upon the utilization and preservation of our forest resources.

Within recent years both public and private funds have been devoted to the establishment of forest schools. Notably to the College of Forestry at Cornell University, the Forest School at Yale, and the Forest School of the Biltmore estate. Courses in forestry have been established in many of the universities and colleges, and it is even proposed to introduce the study into the common and high schools.

There is a notably increased interest in scientific investigations of forest problems manifested by the managers of some of our great railroad systems and by other companies who are extensive manufacturers and consumers of forest products. This is demonstrated by the rapidly increasing demand for special investigations and literature relating to American forests; and it indicates a general appreciation of the value of forests in their relation to public and private interests and the need of their protection.

Investigations within recent years, by the writer, in the hardwood and coniferous forests of West Virginia, the great coniferous forests of the Northwest, the pine forests of the Black Hills reserve, and the spruce woods of Maine, convince him that the depredations by insects on the living timber alone cause injuries amounting to many millions of dollars annually. A study of the insect depredations on forest products, such as railroad and other construction materials, tan bark, and minor products, makes it plain that the actual loss in money and labor amounts to many millions of dollars more each year.

Forest entomology is a branch of economic entomology which treats of insects in their relation to forests and commercial forest products, as distinguished from those which relate to farm and garden plants, and to fruit, ornamental, and shade trees.

While the determination of successful methods of protecting the ornamental and shade trees of private grounds and parks from injurious insects will depend largely upon information contributed by forest entomologists, such trees are, as a rule, grown under different conditions and subject to treatment similar to that applied to fruit trees and cultivated plants, which is not practicable in the forest. The acquiring of information by the forest entomologist involves the determination and classification of the species of forest insects, according to their systematic relations to each other, their relations to the trees they infest, and the economic results of their work; a detailed study of the life history and habits of the more important injurious and beneficial species; a

special consideration of the influences and natural laws which contribute to favorable or unfavorable conditions for their life and work; and the conducting of experiments to determine practical methods of preventing losses from the ravages of the destructive species.

The information to be collected and disseminated is of two kinds: (1) That which is of a technical nature, as contributions to the advancement of science and for the special benefit of students and investigators; and (2) that which is capable of immediate practical application in the management of public and private forests and in lumbering operations.

In addition to a special knowledge of entomology, pure and applied, the student who desires to become a good forest entomologist should have a general knowledge of the science of forest zoology, forest botany, geology, chemistry, physical geography, and economics. It is also important that he have some experience or special training in practical methods of forest management, and knowledge of the manufacture and use of forest products. The universities and especially the forest schools and colleges will give the desired preliminary training in forestry, and works on general entomology, such as those by Harris, Packard, Comstock, Smith, Howard, Sanderson, and other American writers, supplemented by some of the principal foreign works, will fill the requirements for information about insects in general.

After this general knowledge is acquired, together with some training in methods of utilizing published data as guides to methods of study and to the discovery of new facts, the forest will be the school and nature the teacher which will finish the student's course and determine his right to a degree. Indeed, the student who will attain the greatest success in this, or other branches of entomology, will be the one with a natural or acquired ability and love for the work who will seek out the insects in their natural haunts and rely upon and cultivate originality in methods of observation and in collecting and recording data on which to base conclusions.

There is, perhaps, no branch of science which offers greater opportunities for the discovery of new facts and the contribution of valuable information than forest entomology. In this field very little is known compared with what there is yet to be learned. Especially is this true in regard to the life history, habits, and distribution of the injurious and beneficial species. Yet this knowledge is of the greatest importance in determining and applying methods of preventing losses.

There are, indeed, hundreds of subjects and special problems in forest entomology worthy of a lifetime study by as many specialists. There are many families, groups, and genera of insects represented by the principal enemies and friends of the forest which are sadly in need of detailed study by specialists for the accurate identification of the species and a complete revision of the literature. The insects of

the pines and spruces, the cedars, oaks, and hickories, and many others of our principal forest trees, offer excellent opportunities for original investigation and the contribution of information of great importance.

METHODS OF WORK AND STUDY.

In addition to general methods of collecting, preserving, and mounting insects, as given in text-books on entomology, some suggestions may be offered for studying forest insects and for the investigation of their work.

First of all, the student should keep in mind that there are many collectors of insects and many students in general entomology, as well as numerous specialists who are collecting and studying insects of all orders found in the forest and field. Thus he should avoid general collecting, and devote his time to the accumulation of specimens and observation on life histories and habits of insects which are associated with injuries to forest trees or forest products.

In addition to a general study of insects which have some economic relations to forests, he should select, at as early a date as possible, some special subject for detailed study. There is no lack of important subjects, as has already been suggested, but in making the selection the prevailing conditions, opportunities, and facilities in the immediate vicinity or sections in which the studies are to be conducted should be considered. If it is in a pine region, insects affecting pines will offer the most desirable opportunities for study; if in a hardwood region, those affecting the oaks, hickories, chestnut, and the like will offer the best opportunities. If there is some prevailing injury to a given kind or class of forest trees, this will at once suggest itself as the most important to take up. It matters not whether it is the study of the insect fauna of a species or genus of forest trees, the causes of a special class of injuries, or the study of a single family, genus, or species of insect. There is enough in each case to keep the student occupied in original researches for many years, and to furnish sufficient material for contributions to the literature of the subject. Indeed, every student who takes up forest entomology as a life work should start out with the object of acquiring and disseminating as much knowledge as possible on some special feature of the science. To thus become a specialist of this kind does not necessarily imply that he will have a narrow comprehension of the entire subject. Even if one were to try to find out all that is to be known about a single enemy of a forest tree, and every possible method of preventing losses from its work, his work would involve a general knowledge not only of forest entomology in its broadest sense, but of all related sciences and subjects. In fact, as a great thinker has said, in order to know all about any one thing it is necessary to know all about everything. While this may not be literally true, it is becoming recognized that there is almost an unlimited interrelation of all sciences and all subjects.

The equipment for collecting specimens need not be expensive or elaborate. The necessaries are: A hatchet or light ax, carried in a scabbard, which may be fastened to a stout belt; a hunting coat, or an ordinary sack coat, with many pockets; a supply of collecting vials of various sizes, fitted with the best cork stoppers; a small bottle of alcohol; a medium and a small cyanide bottle; tweezers; camel's hair brushes; a stout knife with small and large blades; a small saw; a net and umbrella; and last, but not least important, a notebook and pencil. With this equipment, or such part of it as is required for the special kinds of specimens desired, a good observer can go out in the woods any day in the year and find plenty of material.

The best places to collect species infesting wood and bark is along the edge of the woods, or where trees have been girdled or felled a few months previous. Here one will usually find in the bark of the roots, stumps, main stems, tops, branches, and twigs different stages of many species of bark-beetles and bark-inhabiting larvæ, together with their natural enemies and associates; and the wood will yield many more.

Lumbering regions and sawmill yards are especially prolific in specimens at all times, as are also broken branches, individual trees, and groups injured or killed by insects, felled by storm, or otherwise rendered attractive to insects. During the spring, summer, and fall the foliage will yield specimens almost unlimited in number and variety. But one should remember, as has already been indicated, that it is not the number and variety, but those of most importance, that are to be sought out, noted, collected, and studied. It is often better to spend a day in the diligent search for all that can be found in or on a single tree, or in observing and recording in the notebook all that can be found out about a single species, than merely to collect hundreds of specimens or many species without careful records.

Indeed, the proper recording of what one sees at the time the observations are made is of the greatest importance, and is the one thing the student should practice more, perhaps, than anything else.

RECORDING OBSERVATIONS.

While nearly every entomologist has adopted some system of taking and keeping notes on observations in the field or laboratory which is specially adapted to his own line or method of study, and shows marked peculiarities, there are certain general principles and rules which should be laid down for the consideration and guidance of the student and amateur investigator.

In collecting specimens and in field observations the notes taken should include the following: The exact locality (the nearest post-office, hill, mountain, or farm); when possible, the elevation and the exposure; the date; the host plant; point of attack; what stages

occurred, etc. If it is associated with any special injury or trouble affecting the plant or object from which it obtains its food, the fact should be noted. As many details as possible should be briefly or fully noted. Every separate note referring to collected material should be numbered. In regard to the use of numbers, it should be specially remembered that the numbered specimens serve as an index to the notes relating to them. Therefore the same numbers should never be used a second time. The student should start out with the idea of using consecutive numbers as long as he collects insects. At the same time economy should be practiced in the use of numbers, and this can be accomplished in many ways; as, for instance, No. 1 may be made to refer to more than 100 different entries relating to insects collected on the same date and from the same tree. It may be used 26 times with a letter of the alphabet preceding it (as a1, b1, etc.), 26 times more with letters following it (as 1a), 26 times more with a letter over it, and indefinitely with decimals or fractions. The object in view is to adapt the numbers to all requirements without the necessity of repeating or having them attain inconvenient proportions.

If the object in view is simply to get the specimens, then the locality and date, with the collector's name, are all that is necessary to accompany the specimens in the bottle or on the pin. If the student has ambitions, however, to accumulate material and data which will be of the greatest value, he will give special attention to the accumulation of material which represents more than localities and dates. Our museums and private collections are already oversupplied with this kind of material, which is well enough as far as it goes; but the student who would be satisfied to go no further than this had better not enter the field of forest entomology. His place would be in the museum with dead specimens—a place, by the way, where a vast amount of good and indispensable work is done in systematic study and identification of specimens; but this is in the line of pure science, while the forest entomologist's ambition should be to contribute to the advancement of both pure and applied science. He can do this best by recording as many facts as possible about the specimens he collects and observes.

After the student has progressed far enough to be able to accurately identify the principal species as they are observed in the field, very many observations may be recorded without collecting specimens or the use of numbered notes. But this should not be attempted until after years of practical work, and even then it can not be reliable except with such species as are perfectly well known. Observations and records based on field identifications by some of our best entomologists have led to much confusion in literature about some of our common insects. This has been abundantly demonstrated by the writer in a recent study of the types of Scolytidæ, described by one of

the best American authorities on the Coleoptera of North America. There are a number of examples where a common enemy of forest trees has been identified from descriptions or from observation in the field as a certain species, and after a great deal has been published under the erroneous names it has been found upon comparison with the types that it was quite a different thing, with different habits from the species to which the name properly belonged; and in some cases what was supposed to represent a well-known species was even found to be undescribed. It will, therefore, be readily seen how important it is for the species we write about to be accurately identified, and how necessary to have a numbered specimen to refer to for future corrections or to send to a specialist for authentic identification.

It is always of the greatest importance to observe the character of the work of the insects when found in their natural feeding or breeding places; and, whenever possible, specimens of the work should be secured for the collection, especially the work of wood and bark boring species and that showing special or characteristic injuries to the foliage, etc.; and each should, as with the insect specimens, be accompanied by the note number.

It is also important for the beginner to collect large numbers of specimens both of the insect and its work whenever the opportunity offers. For, even if there should be more than he needs for his own collection, they may be specially valuable for exchange with other collectors for desirable material from other localities and countries. One of the commonest mistakes made by most young collectors, and, for that matter, many older ones, is the failure to avail themselves of the very first opportunity to collect an abundance of material relating to any desirable species. It must be remembered that because an insect is common at one time or place it does not always follow that it will continue to be so or that it is common in other places. Indeed, the reverse is the rule. A period of great abundance is usually followed by a period of great rarity, or, as has sometimes happened, almost complete extinction.

The collector should be constantly on the lookout for the natural enemies of the principal injurious species. One class of the enemies of insects consists of parasitic Hymenoptera, Diptera, etc., found in the adult larval or pupal stage, associated with their host, the larvæ as external or internal feeders on the larvæ, pupæ, or adults of the injurious species, and the adult parasites ovipositing on or in the victims, or in the bark or other infested parts of the plant. The other class of insect enemies of insects are predatory species of Coleoptera, Hemiptera, Hymenoptera, and other kinds of insects which attack and kill their victims, and either devour them or suck out the liquid parts of their bodies. There are also insect diseases which may be indicated by a white powdery substance on the bodies of the dead

insects, and, whenever numbers of examples are found to be dead or dying, specimens should be collected and submitted without delay to some specialist on this class of diseases.

METHODS OF COLLECTING AND REARING LIVING MATERIAL.

It is always desirable to collect living material to rear or breed for the purpose of securing data on life histories and habits. This will consist of eggs, larvæ, and pupæ of foliage-infesting insects to be reared in breeding cages; also bark, wood, branches, and twigs infested with immature stages, to be reared to adults in breeding jars, boxes, or cages.

Specimens from the foliage should be collected in small tin boxes, together with a small amount of their natural food. Some of the smaller things may be reared in the boxes in which they are first collected, if supplied from time to time with fresh food material, while others must be transferred to breeding cages or larger tin boxes. Living specimens in wood or bark are easily collected in sections cut from the infested parts of the plant, and carried in the larger pockets of the hunting coat; or, if a long distance from the laboratory, they may be packed in bundles or boxes and shipped by the most convenient method available.

For breeding specimens from this kind of material, the writer has secured excellent results by the use of different-sized fruit jars with clamp covers. The screw-topped jars are also very convenient for this purpose. For very large sections, or a large amount of material of one kind, tight barrels or large wood or galvanized-iron boxes may be used to advantage.

For carrying on the more elaborate work of rearing from wood and bark, a specially constructed insectary is necessary. Wood and bark infesting larvæ and pupæ, and parasitic larvæ in cocoons, may be successfully reared to adults in bottles or vials which are just large enough to accommodate single specimens. These small vials with cork or cotton stoppers are indeed specially convenient for the rearing of parasitic larvæ and pupæ taken from the mines or pupa cases of the wood or bark-inhabiting host.

PRESERVING, MOUNTING, AND LABELING SPECIMENS.

The specimens that are killed in 25 per cent alcohol should be removed from the bottles in a day or two after they are collected, then cleaned thoroughly and replaced in clear 80 or 90 per cent alcohol. The specimens killed in the cyanide bottle should be gone over, separated, and either mounted or stored where they will be free from museum pests.

The specimens of work of insects should have the surplus parts removed, and should be labeled and stored where they will be readily

accessible for future reference. Broad shallow drawers or trays are convenient for the smaller wood and bark specimens, while wood or heavy paper boxes serve for larger ones. Common florists' paper boxes, which are shipped flat ready to be made up, are excellent for storing the classified material.

Every individual specimen should have the number of the note referring to it, or the series to which it belongs, and also something to designate the particular set of notes or accessions catalogue to which the number refers, as "500, Hopk., W. Va.," which means entry No. 500 in the accessions catalogue of the entomological department of the West Virginia Agricultural Experiment Station, Morgantown, W. Va., A. D. Hopkins, collector. As long as the specimens remain in the collection with the catalogue these accession numbers are all that is necessary for the duplicate material, since they serve at once as index to the readily accessible notes. If, however, any of the specimens are transferred to other collections they should always bear labels showing date, host, and such other facts as are of primary importance to preserve their identity, or if a large number of examples of different species are sent a list of species and accessions catalogue numbers with extracts from original notes should accompany them, together with the address of the individual or institution having permanent charge of the accessions catalogue.

The specimens of the work of insects may have the number and other data written on them, or on paper labels and pasted on or otherwise attached. If the specimens are fastened on cardboard or to the bottom of the case, labels may be printed and pasted beneath them.

WHAT TO STUDY.

After the student has acquired some knowledge of how to study, collect, and make proper records of observations, and how to label and preserve specimens, it is important for him to consider well what there is of importance to study and investigate, and how to get results of practical value. Forest entomology embraces only such insects as are in some way related to human interest in forests and forest products. Therefore, the student must confine his studies to the insect fauna of the forest growth which is of some economic importance, with the view to determining which kinds are injurious, which are beneficial, and which are neutral in their relation to the life history of the plant and the future usefulness of its products.

Commencing with the matured seed or fruit of trees, such as the oaks, hickories, walnut, and others, we find that not only the nut or seed, but its envelope (hull or pod), is the home of many kinds of insects. On the tree, fallen, stored for use, or planted in the ground, they support some different kinds of insect enemies or guests, as they do, also, from the time the seed bursts open and the roots and stem

begin to form through all stages of the seedling, the sapling, the young, matured, old, dying, dead, and decaying tree. Not only does the tree, during each stage in its life history, death, and decay, support some kind or kinds of insects peculiar to each, but every part—the rootlets, the larger branching roots, the main roots, the lower stem, the upper stem, the large and small branches, the twigs, the buds, the young leaves, the flower buds, the different parts of the flower, and the embryo fruit—will have its special guests. Some kinds inhabit the outer bark; others, the intermediate or inner bark, the cambium, the outer or inner sapwood, the heartwood, or the pith.

Not only during its life, but from the time it dies until it is entirely decayed and converted into humus, a tree supports many and varied forms of insect life. Some are its enemies, some its friends; others, neither enemies nor friends, but guests and scavengers. Among its enemies some have special designs upon its life in order that its dying may furnish favorable conditions for the rapid increase of the insect progeny, and consequent increased power in numbers to attack and kill other trees. Some are enemies only to the extent of causing injuries to the roots, bark, wood, branches, and foliage which may be detrimental to its perfect development or its future usefulness to man, but have little or no immediate effect upon its vitality. Others are enemies only so far as they obtain their food from some living part, yet do no permanent injury, such as certain kinds of leaf-eating, sap-sucking, and gall-making insects, which are never or rarely common enough for special harm. There are many other kinds which obtain their food directly from the dead parts of the living tree, such as the outer bark, dead twigs and branches, dead wood, etc., which can scarcely be considered as enemies of the living tree. Among the friends of the living tree are the insects which feed upon the injurious kinds, either as internal or external parasites, or those which attack and devour their prey. Among the guests of the injurious and beneficial inhabitants of the tree there are many kinds which live in the burrows and feed upon the sap, borings, excrements, dead insects, etc., while there are many other kinds which utilize some part of the tree or the burrows of other insects as hiding or hibernating places.

THE INSECT FAUNA OF FOREST PRODUCTS.

The natural products, such as nuts, medicinal roots, bark, and leaves, tan bark, etc., each, under certain conditions of storage and age, furnishes feeding and breeding places for many kinds of injurious, beneficial, and neutral species. The manufactured or commercial wooden products of all kinds, the crude round or square timbers, lumber, staves, hoop poles, etc., are, under certain conditions, subject to attack or serious injury from various kinds of insects while in the woods or

when stored in yards and factories. The seasoned and finished products, especially those from sapwood, may be infested and destroyed by a number of species of so-called powder-post beetles. Construction timbers and lumber, either before being utilized or while in the structure, are subject to injuries by many injurious and other species. The old lumber and timbers of barns and outbuildings, old log and frame dwelling houses, are also infested and injured by forms which are peculiar to such material.

THE ECONOMIC RELATION OF INSECTS TO FORESTS.

The preceding references to the insect fauna of forest trees and their products are suggestive of the vast numbers of kinds, groups, and societies of insects and the kind and character of injuries to be studied. This leads us to a consideration of the economic relation of insects to American forests under the varying conditions which prevail before and after the country is settled and its resources developed.

The relation of injurious insects to the primitive forests.—The relation of insect enemies of a forest before its resources are available to civilized man is of little or no economic importance. They are simply factors in the general struggle for existence between insects and trees, and between the individuals of the forest community in which the destruction of an individual tree by insects is a benefit to other insects and other trees. If a matured or old tree is killed, it gives more room for the development of the younger and more vigorous ones. The injured, declining, and old individuals furnish breeding places for successive communities of insects, which contribute to their death and rapid decay. Thus the young tree growth is favored by light and plant food, and soon fills up the vacancy. Invasions of destructive insects may cause the death of one kind of tree growth over vast areas. This favors the enormous multiplication of the insect fauna until the destructive species perishes for lack of food supply, or from the multiplication of its natural enemies. This proves to be a calamity to the other insects which have depended upon the destructive species to furnish, in the dying and dead trees, the required conditions for their existence. The dying and dead trees and the fallen and decayed branches, bark, and roots contribute to a more vigorous reproduction, so that the forest found by the pioneer settler has lost nothing from its insect enemies.

The relation of the insect enemies of trees to the pioneer settler in a forested country may be more beneficial than otherwise, so far as his immediate needs are concerned. The forest must be cleared from the land that is desirable for agricultural purposes, and in this process the depredating insects may be decidedly beneficial. They contribute to the death and rapid decay of the girdled trees in the clearings and hackings. Invasions which cause the death of the large timber over

great areas may be utilized to the especial advantage of the agriculturist, and contribute to the prosperity of the community of settlers. The dead trees, with the fallen tops, furnish the most favorable conditions for the process of clearing by fire. It saves the expense of girdling. Often the flint and tinder or the torch was all that was necessary to start a conflagration which effectually cleared the land of dead and felled timber, and killed the remaining living trees and young growth.

The relation of insect enemies to the forest of a settled country.—The great destruction and waste of the best of the forest resources necessary to the progress of civilization finally reaches a stage at which the forest is more valuable for its commercial products of timber, its protection of springs and head-water streams, than is the land for agricultural products. Thus as time progresses the insects become more and more injurious in their relation to the public interests. The destruction of matured timber by insects comes to be recognized as a serious loss. Their burrows in the wood of living and dead standing timber and that felled for saw logs and other purposes are recognized as serious defects which reduce the profits of the manufacturer and increase the prices of the clear product to the consumer. The injuries to the young growth which result in the development of a deformed, worthless tree become an element of future financial loss. The areas of dead timber killed by insects become a menace to the forest, furnishing as they do favorable conditions for the outbreak of destructive forest fires and the development and spread of wood-boring insects.

While the more destructive kinds of bark-boring insects may aid in the death of girdled trees, such trees at the same time furnish favorable conditions for the rapid multiplication of the insects and thus contribute to destructive depredations on the valuable living timber in the adjacent forests.

As the merchantable timber and the manufactures of wood become scarcer and the price to the consumer increases, the depredations which a few years before would have remained unnoticed attract more and more attention, and the need of methods of preventing losses from this source is fully realized. Then requests are made for information relating to the kinds of insects that cause the troubles and the details in their habits which is necessary in order to successfully combat them.

Their relation to the public and private forests and farmers' wood lots.—The relation of injurious insects to forests which are under systematic management present quite a different problem from those relating to more primitive conditions. In dealing with the latter there is little opportunity for the practical application of a knowledge of forest entomology, but the former present economic problems worthy of special study and investigation. All of the injurious species may be considered in this relation as enemies, not only to the forests but

to public interests. The introduction of forestry methods offers opportunities for the adoption of methods of preventing much of the losses which under previous conditions could not be avoided. It also offers opportunities for extended research and experiments for the determination of the more important facts relating to the habits and life histories of the insects and their depredations, which will lead to the discovery of improved methods of control.

THE KINDS AND CHARACTER OF THE WORK OF INSECT ENEMIES OF THE FOREST.

The fruits of forest trees are injured by the adults and larvæ of species which feed upon the pulp, pod, or other covering, and thus destroy the seed or prevent its normal development. The seeds are injured or destroyed by beetles and their larvæ, by the larvæ of moths, and by gall-making insects. Nuts of all kinds and the hard fruit of many trees are infested by larvæ from eggs deposited in the growing fruit by small beetles. The entrance of the young larva through the young, tender hull or outer shell heals over so that the ripe nut shows no trace of it. The larva feeds on and destroys the germ and kernel and, when fully grown, bores its way out and enters the ground, where it goes through the transformations and emerges as an adult next year in time to deposit its eggs in the young nuts. Thus the seeds of some trees may be so completely destroyed that few remain for reproduction. This may cause considerable expense and loss to the forester, both in adding to the expense of collecting a sufficient quantity of sound seeds and in causing an uneven stand in the nursery on account of the damage to the stored and planted seeds. This class of injuries also causes a serious loss of the commercial product of chestnuts, hazelnuts, hickory nuts, etc.

The seedling in the forest or in the nursery row is attacked and injured by many kinds of insects. The roots are eaten by the larvæ of beetles and the sap sucked out or poisoned by root-lice. The stem is attacked by wood and bark-boring beetles and grubs. The foliage is devoured by caterpillars, larvæ of sawflies, and grasshoppers, or injured by plant-lice, scale insects, leaf-hoppers, and leaf-bugs. The twigs are injured by twig girdlers, twig miners, scale insects, and plant-lice. As a result, the seedling may either be killed or become stunted or deformed.

The young tree is in a like manner attacked and injured or killed by one or more enemies of the roots, stem, or top. The principal injuries, however, which are characteristic of the growing tree, are those made in the roots and base of the stem by the great root borer, and in the wood of the main stem by the carpenter worms and other borers, which are capable of working in the wood of living healthy trees. While this class of enemies may have little or no direct effect upon the vitality of the trees infested by them, they cause a great loss

of commercial products. Their burrows cause defects in the wood, and are the means of starting decay, which renders the heartwood worthless for commercial purposes. The living bark may be attacked by bark-boring grubs in sufficient numbers to seriously affect its vitality, so that it will soon succumb to the attacks of other insects or diseases.

The mature tree suffers most from the many wood-boring beetles and grubs. The destruction of some of the larger roots by the great root borer causes dead branches and dead tops. The borings of the carpenter worm and other borers in the main trunk, top, and larger branches result in rapid decay, hollow trunk, and generally worthless condition, while its weakened vitality makes the tree an easy prey to destructive bark-boring enemies. The trees blown down by storm or felled by the ax are attacked by a vast number of species of insects. Some live in the bark, where they do little or no harm to the commercial product, but certain kinds may thus multiply rapidly and attack the standing timber. The wood, however, may be seriously injured by many species of wood-boring beetles and grubs which breed only in the wood of dead and felled trees.

Old dead, standing, and felled trees and old logs and stumps are infested by many insects which not only contribute to the rapid destruction of the wood, which otherwise might have some commercial value, but certain kinds breed in such material and emerge to attack the wood of recently felled trees and injured places in the standing living ones. They also attack square timbers in bridges, trestles, railroad bed, etc.

SOME OF THE PRINCIPAL INSECT DEPREDATIONS IN THE FORESTS OF THE UNITED STATES.

THE PINES.

Between 400 and 500 species of insects are known to inhabit the living, dying, and dead pines of the United States. The pine forests of the East, Northeast, and Southeast have suffered and are now suffering greatly from the ravages of destructive bark-beetles. A few years ago (1890–1892) a trouble spread over an area of 75,000 square miles in the Middle Appalachian region which resulted in the death of millions of pine trees. This included all of the indigenous and some of the introduced species in the forests, private grounds, and parks. Upon careful investigation, this trouble was found to be caused primarily by the ravages of a single species of bark beetle (*Dendroctonus frontalis* Zimm. var. *destructor* Hopk.). Previous to 1890 this was a rare insect in collections, and nothing was known of its habits. It disappeared and the trouble ceased in 1893. This insect is liable to appear again in destructive numbers. It is therefore of the greatest importance that special efforts be made to determine the sections in the Eastern and Southern pine forests where it may yet survive, so

that measures may be taken, by introducing or encouraging its natural enemies or by girdled trap trees, to prevent its multiplication and future destructive invasions.

Recent investigations in California, Oregon, Washington, and Idaho, by the writer, under the auspices of the Division of Entomology, United States Department of Agriculture,[a] revealed the fact that the western yellow pine, Jeffery pine, sugar pine, mountain or silver pine, shore pine, and lodgepole pine has each its peculiar insect enemies, some of which are very destructive. Many of the finest examples of yellow pine were found to be dead or dying from the ravages of the western pine destroyer (*Dendroctonus brevicomis* Lec.) from northern California to northern and western Idaho. The mountain pine in northern Idaho and western Montana suffered severely from the ravages of the mountain pine destroyer (*Dendroctonus monticola* Hopk. MSS.). The yellow pine has also suffered greatly in Idaho and eastern Washington from the larvæ of a white butterfly (*Neophasia menapia* Feld.), which defoliates the trees over large areas.

Recent (September, 1901) investigations in the Black Hills forest reservation revealed the fact that a vast amount of the best timber on many thousands of acres has died within the past six or seven years and is yet dying from the ravages of the pine-destroying beetle of the Black Hills (*Dendroctonus ponderosæ* Hopk. MSS.).

It is also reported that the pine is dying in other sections of the Rocky Mountain region, from Idaho to Arizona, evidently because of the ravages of bark beetles.

It is evident from observations made in the Black Hills reservation and in the forests of Idaho, Washington, and Oregon that the death of the pine timber over many extensive areas, supposed to have resulted from fires, was primarily due to the work of tree-destroying insects. Even the meager knowledge we have been able to acquire during hurried investigations in the forest and from observations along the routes of travel through the Rocky Mountain region, the Pacific slope, and the Northwest makes it very plain that the destruction of pine timber, due primarily to the ravages of insects, has been progressing during the past half century at a rate far beyond that conceived by the casual observer or even by those who are making a study of the forests and forest conditions of those regions. Indeed, the extensive ravages of insects on the pines of the United States furnish a problem whose great importance and magnitude would justify the expenditure of large sums of money for detailed investigation by specially trained forest entomologists.

THE SPRUCES.

The spruces of this country are also inhabited by many hundreds of species of insects.

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[a] Bul. No. 21 (n. s.), Division of Entomology, U. S. Department of Agriculture.

The Red Spruce of the middle and northern Appalachians, from West Virginia to northern New York and on through northern New England to Canada and New Brunswick, has, from time to time during the past century, suffered severely from troubles, some of which are known, and others believed to be, caused by bark-beetles.[a]

A large amount of spruce was killed in West Virginia about 1885, evidently by a bark-beetle, but the trouble was not investigated until 1890, so the exact species deserving the blame could not be determined.

In 1892 the destructive pine bark-beetle spread in West Virginia from the pine into the spruce, and caused the death of a large amount of the best timber.

The great destruction of spruce, which has attracted so much attention from New York to New Brunswick, was found, upon special investigation, to be largely if not entirely due to the primary attack of the spruce-destroying beetle (*Dendroctonus piceaperda* Hopk. MSS.).[b]

The Sitka Spruce of the Northwest has numerous enemies, among which the Sitka spruce Dendroctonus (*Dendroctonus obesus* Mann.) is the principal depredator in the bark of living and declining trees, while the spruce-destroying spanworm (*Philedia punctomacularia* Hulst.?) may be considered as the greatest insect destroyer of forests of this tree and the Western Hemlock.[c] Scarcely anything is known about the life history and habits of this insect. Therefore it presents a problem of special importance for investigation.

The Engelmann Spruce has a number of insect enemies, one or two of which are capable of causing wholesale destruction.

Vast quantities of dead spruce occur in different sections of the Rocky Mountain region which, it would seem, bear no trace of having been killed by fire, and the cause will probably be found to be the attacks of some destructive bark-beetle or defoliating insect.

THE HEMLOCKS.

The Eastern Hemlock has a serious enemy in the hemlock destroyer (*Melanophila fulvoguttata*), which has caused the death of a large amount of hemlock timber throughout the Appalachian and Northeastern regions.

The Western Hemlock has at least three destructive enemies of the living trees: (1) The Western hemlock bark-borer (*Melanophila drummondi*), which is closely allied to the Eastern species, and like it extends its burrows beneath the bark and either kills the trees or causes serious gum-spot defects in the wood; (2) the Douglas spruce

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[a] Buls. 17 and 56, W. Va. Agr. Expt. Station, and Bul. 28 (n. s.), Div. Entom. U. S. Dept. Agr.

[b] Bul. 28 (n. s.), Div. Ent., U. S. Dept. Agr.

[c] Bul. 21 (n. s.), Div. Ent., U. S. Dept. Agr., 1899, p. 18.

bark-borer (*Asemum nitidum*), which has similar habits to those of the hemlock bark-borer; and (3) the Sitka spruce spanworm, which defoliates and kills the trees over large areas.

THE CEDARS.

The California Redwood has a special enemy in the sequoia bark-beetle (*Phlœosinus sequoiæ* Hopk. MSS.)

The Giant Arborvitæ has an enemy in *Callidium janthinum*, and the Eastern Arborvitae one in *Hylotrupes ligneus*, which infest the living trees and either kill them or cause serious defects in the wood. The other true cedars, the Monterey Cypress, and some of the Western and Eastern junipers, have a number of bark- and wood-boring enemies, which are more or less destructive.

THE FIRS.

The Western, grand, noble white, and Shasta firs, and the Eastern balsam firs are attacked by several destructive bark-beetle enemies, which either kill the trees or cause serious gum-spot defects or decayed places in the wood.

THE OAKS.

The insect fauna of the oaks is very large, probably exceeding in number of species that of the pines. Those noted for their especially destructive attacks on living trees are the carpenter worms (*Prionoxystus* spp.), which bore into the bark and wood and not only cause serious worm-hole defects, but by successive attacks cause the death of part or all of the tree. Their burrows give entrance to wood-decaying fungi which soon render the heartwood worthless for commercial purposes. The giant root-borer (*Prionus laticollis*) is another enemy of Eastern oaks in general, which is enormously destructive to large and small trees in forest, park, and lawn; but it would seem that its work is rarely recognized, and that the magnitude of the damage is not generally understood. The large, white, elongate grubs bore in the roots and bases of the trees, causing one or more of the larger roots to die. These holes and the burrows made by the carpenter worms give entrance to other wood-boring insects and wood-destroying fungi, which rapidly extend and complete the destruction of the injured parts. This decay often extends into the base of the trunk, destroying the heartwood and thus causing the tree to be hollow and worthless. The decayed wood of the roots and base of the tree also furnishes fuel for forest fires, so that the trouble started by the giant borer, and extended by other insects and fungi, is made conspicuous by a great blackened wound, which is more often than otherwise supposed to be due to fire alone. Trees are often killed outright by this root destroyer, but the work is usually so obscure that the trouble is often blamed to

other bark and wood-boring insects, which attack the tree as soon as it manifests weakened vitality.

The two-lined chestnut borer (*Agrilus bilineatus*) is another enemy of medium to large white oak and other oak and chestnut trees, which has caused the death of a large amount of this kind of timber throughout the Appalachian region.

The oak timber worm (*Eupsalis minuta*) is one of the most destructive enemies of the wood of living, dying, dead, standing, and felled trees. It causes what is known as pin-hole defects. The loss of the more valuable timber of the largest and best trees caused by this insect is enormous; indeed it is far beyond the conception of persons who have not given special attention to the subject. The ravages of this insect do not end with living and dead trees, but it continues its work in lumber and square timber from infested logs, and will even attack freshly sawed and closely piled oak lumber. This insect alone furnishes one of the big problems for detailed investigation.

The Columbian timber beetle (*Corthylus columbianus* Hopk.) causes one of the commonest defects in white oak lumber and square timber. It attacks and breeds in the sapwood of living trees, and the healed-over wounds cause pin-hole and stained-streak defects.

A serious trouble has for many years affected the oaks of the northern United States from New York to Minnesota, and has caused the death of a vast amount of timber in lawns, parks, and the forest. This has not been specially investigated, and therefore little or nothing is known regarding the primary cause.

THE CHESTNUT.

The living chestnut trees throughout the Appalachian region, and apparently wherever this tree grows, have a most destructive enemy in the chestnut timber worm (*Lymexylon sericeum*). This wood-boring worm or grub hatches from eggs deposited in the slightest wound in the bark and surface of the wood, and burrows deep into the heart-wood, causing the wood of nearly every old tree to be perforated with pin-hole defects. It attacks and breeds in dying, dead, and felled trees and stumps, and will continue to work for a time in square timber, telegraph poles, and heavy timber cut from infested trees. It also infests red oak, and often renders worthless parts of the trees which otherwise would make the highest grade timber. The enormous damage to the forest resources of the United States caused by this insect makes it one of primary importance to take up for detailed study and for exhaustive experiments with different methods of reducing the numbers of the pest and preventing losses from its ravages. The giant root-borer and the two-lined chestnut borer also attack chestnut, and in some sections do great harm.

THE HICKORIES.

The hickories of lawns, parks, and forest have suffered from time to time within the past half century from the destructive ravages of the hickory bark-beetle (*Scolytus 4-spinosus*) from Missouri to northern New York and West Virginia. Recent investigations and extensive experiments with felled and girdled trees indicate that this pest can be controlled so that under a system of improved forestry management little or no loss should result from its attack.

The poplar, tulip, beech, birch, and, in fact, all of the principal forest trees have their special insect enemies, which attack the living trees and are more or less destructive to their lives or to the commercial value of their timber products.

DEPREDATIONS IN THE WOOD OF DYING, DEAD, AND FELLED TREES, TIMBER PRODUCTS, CONSTRUCTION TIMBER, AND STORED PRODUCTS.

In addition to the primarily destructive enemies of living forest trees, there is a host of enemies of the wood of the dying and dead standing and felled trees of all species, which cause serious defects and rapid deterioration. Many of these injuries to the wood present problems of great economic importance and most promising lines of investigation in the possibilities of discovering simple methods of preventing losses.

Construction timbers.—There are a number of wood-boring insects which attack and breed in heavy construction timbers, especially those used for railroad ties and in culverts, trestles, and bridges. These are not only weakened by the borings of the insects, but entrance is given to wood-decaying fungi, which work so rapidly that, before it is realized, certain parts may be rendered exceedingly dangerous. Therefore, the relation of the combined effects of insects and fungi to accidents from the collapse of buildings and railroad structures is a subject of special interest and importance for detailed study.

Stored forest products.—Insect depredations on stored forest products, such as tan bark, hickory handles, buggy spokes, and hoop poles, is another problem coming within the range of forest entomology which demands special attention. Recent investigations of insect enemies of stored tan bark have revealed the fact that both oak and hemlock bark are subject to attack by at least five species of insects, which convert into fine powder the inner or flesh part of the bark that has been stored over two or three years. As much as $70,000 worth of hemlock bark was found to be infested at a single tannery in West Virginia, and personal investigations at other tanneries in the State, together with information from other States, indicate that this is a widespread trouble in the East and North and evidently extends into Canada.

The destruction of stored hickory, oak, maple, and other hardwood lumber, and the various products manufactured from hard woods, due to the ravages of powder-post beetles (*Lyctus* spp.), is a widespread trouble in this and other countries, and has caused the loss of a vast amount of valuable material. Yet comparatively little has been done in this country toward a detailed study of the problem and the elaborate experiments necessary to determine methods of preventing attack.

THE INTERRELATIONS OF INSECTS, FUNGI, AND FIRES IN THE DESTRUCTION OF FORESTS.

This is another problem that recent investigations have demonstrated is one of very great importance. Heretofore it has been almost entirely overlooked, and much of the destruction which has been going on in all of the great forest areas of the country that is primarily due to insect attack, and secondarily to fungi, has been attributed to forest fires, which really occupied third place among the destructive factors.

The examples of destructive insect ravages mentioned here are only a few of a long list that could be given. They should be sufficient, however, to indicate the number and the magnitude of the problems in forest entomology, which, on account of their special economic importance, should be thoroughly investigated.

The need of exhaustive study of these problems is all the more apparent when it is realized that comparatively nothing is known of the more important facts relating to the life history and habits of some of the principal depredators, the conditions that contribute to sudden and destructive invasions, or those that bring about an equally sudden ending of a serious trouble. Without this knowledge little or nothing can be done toward the recommendation of effectual methods of preventing losses. Enough has been determined from a detailed study of some of these problems to indicate quite clearly that a better knowledge of some of the fundamental facts will lead to the adoption of simple, inexpensive methods by which the loss of a vast amount of timber and timber products may be easily prevented.

REMEDIES AND OTHER METHODS OF PREVENTING LOSSES.

The problem of controlling insect enemies of forests is quite a different one from that relating to the control of farm, garden, and fruit and shade tree insects. Indeed, they must be considered from a different standpoint—that of prevention rather than that of destruction. Thus every separate trouble caused by different insects or the troubles caused by the same kinds of insects in different sections of the country must be studied separately with a view to determining methods of

utilizing some method of management specially adapted to the prevailing conditions in each case, which will reduce the number of the depredators or otherwise prevent losses.

SOME PRACTICAL RESULTS.

A few examples may be given of the practical application of a knowledge of some of the principal facts in the life history, as follows:

The recent determination that the tanbark-destroying insects do not attack the stored bark until it is two or three years old suggested a simple method of preventing losses.

The determination that the spruce-destroying beetle attacks only the larger trees, and that the beetles could be attracted to trees hack-girdled during the proper period in June, suggested important methods of forest management and lumbering operations, which will contribute to the elimination of trouble from this pest.

Girdling and timber-cutting experiments have demonstrated the possiblility of preventing losses from the ravages of insects and wood-destroying fungi by girdling and cutting timber when the physiological conditions are such as to render the bark and wood unattractive to the depredators or unfavorable for their destructive work.

A knowledge of the habits and characteristic work of bark-infesting insects in living, dying, and dead trees furnished conclusive evidence that a large amount of healthy, uninfested, living timber had been cut in the Black Hills forest reserve, where it was intended that none but trees infested by the pine-destroying beetle or those killed by it or other causes should be cut. It was also demonstrated that a knowledge of the principal facts relating to the primary and secondary insect enemies of the pine of this region would facilitate the drawing up of timber-cutting contracts which would avoid much future trouble and litigation relating to the interpretation of references to insect and insect-killed timber.

Facts determined relating to the habit of the pine-destroying beetle of the Black Hills and the relation of other insects and fungi to the trees injured and killed by it suggested methods of future management which would prevent the loss of much timber, and contribute to a better public appreciation of the importance of Government forest reserves and the adoption of scientific forestry.

The facts which have been recently determined from special investigations of the troubles caused by the destructive pine bark-beetle, the chestnut timber worm, the oak timber worm, the giant root-borer, and a number of other principal enemies of Eastern forest trees have made available a fund of information which it is believed can be used to special advantage in formulating future plans for the management of Eastern forest reserves, systematic forestry work, conservative lumbering, etc.

The new facts determined during recent investigations in California, Oregon, Washington, and Idaho relating to the habits of the destructive enemies of the redwood, Monterey pine, Western yellow pine, sugar pine, Jeffery pine, shore pine, mountain pine, and lodgepole pine, and the Western hemlock, Douglas spruce, Englemann spruce, several species of fir, the Western larch, and Western cedars, have made available a fund of information which will be of special service in future studies of the enemies of the principal forest trees of the Western forest reserves.

The extent and magnitude of depredations by insect enemies of the forests and forest products of this country; the comparatively meager knowledge of the essential features in the life history, habits, and natural enemies of the principal depredators on which to base conclusions relating to methods of control or prevention; the possibility, as has been demonstrated, of future detailed investigations leading to the discovery of methods of preventing a large part of the losses; the facilities afforded in the extensive Government reserves and in large private areas where systematic working plans and forest management have been adopted, together with the information available from the results of investigations in this country and Europe, seem to warrant the recognition of forest entomology as a distinct branch of economic science.

The address was most heartily received, and, on motion of Mr. Howard, Mr. Hopkins was voted the thanks of the Association for his able presentation of this very important subject. The discussion of the address was postponed until the opening of the afternoon session and the regular business of the association was taken up. The discussion, however, is here inserted in connection with the address for the sake of continuity.

Mr. Smith stated that he had been much impressed by the address. He thought the subject one of the most important in its way in the United States, and the presentation of much value to entomologists. He knew that there was much injury done to forest trees by insects, but some things in the address impressed him as being contrary to his own experience, especially the statements about the giant root-borer (*Prionus laticollis*). In his experience, though that insect appeared quite generally in oak forests, he had not found it in that tree. According to his observation an old pine log was almost certain to become infested by the larva and to become its home. He had a large amount of material showing this. The line of work followed by him was quite different from that followed by Mr. Hopkins, and he would place the damage done by forest fires far ahead of that done by insects. Mr. Smith considered that in New Jersey the insects followed the

fires. In that State forests are not in as large areas as in many other places, but in comparatively small blocks. Most of the fires are caused by sparks from the railroads, and after that the insects come in and complete the work done by the fires. Mr. Smith's point was not that Mr. Hopkins had been incorrect in his statement, but that what he said was contrary to his own observations in other localities. However, the facts may be different under different conditions. There was one insect in hickory (*Agrilus* sp.) that he had found cutting off the branches. It would work up and down for a little time under the bark, and would then start around the branch and make galleries to the center, until it had actually cut it off. Only recently he had found a number of specimens that had been cut off in this way.

Mr. Hopkins stated that in his investigations of oak trees he had found the giant root-borer to occur around the roots, and had dug them out in large numbers from living as well as dead tissues.

Mr. Smith stated that he had found them in the roots of cherry trees, working in something like the way described by Mr. Hopkins. According to his observations, except in the case of the blackberry, this insect would not breed in entirely living tissue; and he always assumed that, wherever borers were found in the roots of trees, the roots had been injured by some other cause. The insects are very common in pine logs in southern New Jersey.

Mr. Smith further stated that another point which had interested him was in reference to the carpenter worm (*Prionoxystus robiniæ*). It was stated to be a very common insect in the scrub oaks. In southern New Jersey, in the second growth from 6 to 8 inches in diameter, the larvæ got in year after year at the same point. They enter by preference at the place where other insects have made their entrance. If the tree is cut down, one can readily determine the time when the first insect entered. Comparatively small additional borings are made to the original one by succeeding broods. He had made sections in some cases that seemed to indicate that the tree had been infested for at least thirty years. He had found small larvæ working out from the end of old galleries. He thought this case offered a good illustration of the resisting power of trees. Those oaks that were most generally infested had certainly stood up for years under the attacks of the borers. He had noted several interesting cases, showing the relation between the woodpecker and carpenter worms, which indicated that sometimes there may be two woodpeckers after the same larva, and there were many cases where the history of these occurrences have been written out in the tree.

Mr. Felt stated in this connection that he had observed in the parks in Buffalo that the carpenter worm was very common in ash trees and in some sugar maples in St. Lawrence County, and in each instance they went to the heart of the tree. He was inclined to agree with

Mr. Smith that successive generations increased the length of the burrows. He had never seen a case of trees attacked by this insect being broken off by winds. He questioned if the species had been accurately determined in all cases, and thought that possibly there might be more than one species involved.

Mr. Smith was of the opinion that there was but one species engaged in New Jersey, and that this was the very common species. He stated that the imported *Zeuzera pyrina* worked the younger trees in such a way as to weaken them by going around the trunk and girdling it completely under the bark; then the first heavy wind would carry the tree to the ground.

Mr. Felt stated that another species (*Cossus centerensis*) occurred in the vicinity of Albany in poplars, and that its work was quite different from that of the carpenter worm.

Mr. Smith replied that in New Jersey there was another native species which was smaller than the one under discussion; but its habits of boring were different, and the species is quite rare.

Mr. Howard remarked that the Division of Entomology had recently made some examinations, and had found that oaks infested by the oak carpenter worm (*Prionoxystus robiniæ*) were noticeably smaller than trees not infested. The same year the insects were all destroyed in the trees found infested by the use of carbon bisulphid injected into the holes. Six months after he had published his paper on shade-tree insects he had been obliged to change his relative rating of oaks on account of this insect.

Mr. Smith remarked that he had used this method against the wood leopard moth in private grounds in the vicinity of Jersey City. The species has now spread to New Brunswick, but he did not regard it as a dangerous insect there. He had been watching it for many years, as it slowly spread from one city to another. The native birds kept it in check outside the sparrow range; but he had found it occasionally in nursery examinations close to cities, and here the insects might be very abundant, there being no native birds to keep them down. He had found the larvæ almost every year, but rarely in an orchard or on fruit trees, except such as were inside of city limits.

Mr. Scott called attention to a rather remarkable occurrence of one of the powder-post beetles which occurred in a dwelling on Washington street, Atlanta, Ga. His attention had been called to it by one of the inmates of the house, who requested him to make an examination. The trouble had existed for a week, and every day it had been necessary to remove the carpets from the floors and sweep up. An investigation of the cellar of the house and the floor above revealed that the timbers were thoroughly riddled by the tunnels of this beetle. He advised that the city building inspector be called, as the house appeared to be dangerous. He sent specimens of the insect's work to Dr. Howard with the request for a remedy. So far as he knew, nothing had

been done and the usual remedies for injury of this character were here of but little use.

Mr. Sanderson stated that he had had some experience in his own house with a small beetle, about one-third of an inch long, the species being unknown to him. He could advise no means of killing it.

Mr. Quaintance asked if there had been any experiments made in fumigating to rid houses and cellars of white ants.

Mr. Marlatt said that it was very probably true that the subterranean colonies of the white ant would not be reached by the gas treatment, but that if the flooring could be loosened and the gas put as near as could be to the infested region, a great deal of benefit might result. The trouble would come, however, from the fact that the white ant colonies had numerous branches, and many of these would be beyond the foundation of the house. With regard to the use of creosote, he stated that for several years past the recommendation of the use of this substance had been made by the Division of Entomology, and that it was mentioned by himself in a recently published circular on the white ant. The use of creosote referred to was more in the nature of forcing it through the body of the timbers, as well as coating and soaking the exterior, and when so done it was believed to be a very effective means of preventing white-ant damage. The chief objection to it was the expense of the treatment.

Mr. Smith related an experience from New Brunswick, N. J. In one of the churches there had been trouble, and, in taking out the old organ, the timbers were found to be riddled by white ants. He had been consulted in the matter, and, in accordance with his suggestions, the worst infested timbers were removed and replaced with iron beams. Where it was necessary to keep wood, this had been soaked in a creosote preparation. Up to the present time he had heard nothing further of the matter.

Mr. Osborn remarked that it is almost necessary to find the nests of these insects to treat them, but did not consider gas would be effective if the insects were locked up in the timber. He was of the opinion that it would be difficult to kill them by fumigating, as the fumes of the gas did not penetrate to any extent.

Mr. Scott stated that he had spent a number of hours in an attempt to locate the nests of white ants, but that they were hard to find. Soaking timbers with creosote, as stated by Dr. Smith, had been used at different times by him in the South, but had not proven to be of much value. He thought that possibly some system of forcing creosote through the wood might be of value. He had frequently suggested that this be done, but the expense of the creosote seemed to be an objection, and he considered it of little value.

Mr. Hopkins called attention to a very excellent report from the Bureau of Plant Industry, by Dr. Herman von Schrenk, on the treatment of timber for fungi and insects.

Mr. Felt called attention to the fact that in New York State, when they had been suffering from drought, the pine trees had been very badly attacked by bark-borers. The fruit-tree bark-beetle had also been causing injury in the last two years. He had wondered what the cause of this was, and it appeared that this outbreak apparently began at the close of two or three excessively dry years. There was an excessive drought in July and August in that section in 1896, and the trees suffered considerably.

Mr. Hopkins stated that he had noticed that it was claimed that much injury had been caused by drought, but that he was a little skeptical as to the effect of drought on large trees. He had examined a number of the spruce trees, some growing on rocks, and others in the lowlands, where there should be an abundance of moisture.

Mr. Burgess asked Mr. Hopkins if the elms in the woodlands had been much attacked by *Saperda tridentata*. In Cincinnati, a great many of the elms had been seriously affected, and they were losing a large number of their trees. He desired to know if the injury had been general or not.

Mr. Hopkins replied that he had not observed this species in the forest elms in West Virginia.

Mr. Smith stated that, in the case of trees that had been infested by the carpenter worm in the south Jersey pines, he thought that fully nine-tenths of the caterpillars were taken out by woodpeckers. In every tree that is less than 6 inches in diameter, the birds can get at the larvæ without trouble.

Mr. Felt, in reply to Mr. Burgess's question, stated that he had observed the work of *Saperda tridentata* somewhat extensively in New York, and found it confined to shade trees, and not to forest trees, and in some places he had noted considerable injury. Trees 12 to 14 inches in diameter were more commonly injured; in his experience the insect was confined to the American elm.

The secretary presented the following names for membership in the association: Mr. Percy B. Gregson, Waghorn, Alberta, Northwest Territory; Mr. H. W. Peal, Indian Museum, Calcutta, both proposed by Dr. Howard; and Prof. Wm. Lochhead, Guelph, Ontario, proposed by Dr. Fletcher. Messrs. Peal and Lochhead, being official entomologists, the secretary was directed to add their names to the list of members. On motion, Mr. Gregson was elected to membership.

Mr. Felt proposed the name of Mr. J. J. Barden, nursery inspector in in the State of New York. Mr. Osborn moved that a committee of three on membership be appointed to consider the application of Mr. Barden and others for membership. The chair announced as this committee Messrs. Osborn, Smith, and Felt.

The report of the secretary and treasurer was next read, and on motion of Mr. Howard was adopted.

Mr. Smith thought it well to appoint a committee to propose an amendment to the constitution which would permit the revision of the membership lists, and, after considerable discussion, he moved that the matter be referred to the committee on membership already appointed, which was duly seconded and carried.

The secretary next read letters from members who were unable to be present, but extended their best wishes to the association.

On motion of Mr. Howard, a committee of three was appointed to arrange the programme, as follows: Messrs. Marlatt, Smith, and Quaintance.

It was moved and carried, that committees of three each on nominations and resolutions be appointed by the Chair. The Chair stated that these committees would be announced later. The meeting then adjourned to reassemble at 2 p. m.

AFTERNOON SESSION, FRIDAY, JUNE 27, 1902.

The meeting was called to order by President Hopkins, who announced the first paper on the programme to be by Mr. A. F. Burgess.

NOTES ON THE USE OF THE LIME, SULPHUR, AND SALT AND THE RESIN WASHES IN OHIO.

By A. F. Burgess, *Columbus, Ohio.*

Owing to the serious difficulty encountered in successfully treating fruit trees infested with San Jose scale, a limited number of experiments were planned by Prof. F. M. Webster to test the efficiency of the lime, sulphur, and salt wash in Ohio. For this purpose young apple trees were selected about 10 to 12 feet in height and badly incrusted with scales. Mr. Wilmon Newell, late assistant entomologist to the Ohio experiment station, prepared the wash and thoroughly sprayed the trees December 31, 1901. The formula used was that recommended in Bulletin No. 3 (n. s.), Division of Entomology, viz, 40 pounds of lime, 20 pounds of sulphur, and 15 pounds of salt, with the addition of enough water to make 60 gallons of wash after these ingredients had been boiled as prescribed.

The rainfall at Wooster for the month of January amounted to only 0.63 inch, and was distributed as follows:

	Inch.
January 3	0.02
January 11	.05
January 12	.05
January 16	.02
January 21	.40
January 26	.05
January 27	.02
January 29	.02

During the last part of the month snow fell instead of rain, but as it did not adhere to the trees to any great extent, its melting caused little of the wash to be removed.

The climatic conditions were what would be considered favorable for the successful use of this wash.

No careful inspection of the trees was made until May 24, 1902, but previous hasty examinations showed that a large number of the scales were becoming loosened on the trees and were falling to the ground. On the latter date the writer inspected these trees, and was unable to find any living scales whatever, except a few females which were nearly full grown. Ten per cent of the females that had reached this degree of maturity were found to be alive, but on comparing the total number of living scales present on the trees with the number present before the trees were sprayed it appeared that at least 98 per cent had been destroyed.

In Ottawa County the lime, sulphur, and salt wash was prepared by several owners of orchards, and applied to peach trees late in March, 1902, with satisfactory results. In one instance, a heavy storm of hail and rain fell shortly after spraying, and washed considerable of the deposit from one side of the trees. The owner, fearing that the wash would not be effective, resprayed some of the trees on this side, very lightly, with crude oil. On June 14 an occasional live scale could be found, but the treatment appeared satisfactory. On examining some of the trees sprayed at the same time, but which had not been resprayed on one side with crude oil, no perceptible difference was apparent in the number of living scales present.

A single case has been reported on Catawba Island where peach twigs have apparently been injured by this wash. The spray was prepared by the owner, the same formula being used as in the Wooster experiments. A large block of thrifty peach trees was sprayed on March 22 and 26, the weather following being dry and favorable for the effective use of the wash. On examination June 14, the writer found that many of the twigs on some of the trees had died from 4 inches to over a foot from the terminal bud. The foliage below the dead twigs was green and healthy in appearance, but the crop of fruit had been greatly reduced. The greater part of the trees in this orchard, treated in the same manner, showed no injury, hence it is difficult to understand the exact cause of the damage.

The resin wash was also prepared and applied by Mr. Newell to apple trees slightly infested with the San Jose scale. It was made as directed in the bulletin previously mentioned, using 20 pounds of resin, 5 pounds of caustic soda, and 2½ pints of fish oil, and, after boiling for four hours, it was diluted with sufficient water to make 100 gallons. The spraying was done January 8, and the trees were not examined until May 24. At this time only a single living scale was found, although several hundred scales were carefully inspected.

Mr. W. H. Owen sprayed a row of badly infested trees in his peach orchard on Catawba Island with a resin wash, but the formula contained more fish oil than the one above quoted, and caustic potash was substituted for caustic soda.

The trees were sprayed April 15 and 22, and the fruit buds apparently sustained no injury, as a good crop of peaches is growing. It was estimated, after examining the trees June 14, that 98 per cent of the scales had been destroyed.

The results of the limited number of experiments this year indicate that these washes can be used in Ohio with good success, if climatic conditions are favorable, and if the preparation and application is careful and thorough. Whether orchardists will be able to duplicate the results of these tests as satisfactorily on a large scale and under different weather conditions can only be demonstrated in this State by the work of another season.

Basing the cost of materials on quotations received from wholesale firms in Columbus, the lime, sulphur, and salt wash can be prepared for a little over one cent per gallon. The resin wash is considerably cheaper, unless a more concentrated spray is desired. These estimates do not include the cost of preparing the wash, which takes considerable time, and should the materials be bought at retail prices the expense would be increased.

After the conclusion of Mr. Burgess's paper, it was voted to defer discussions until all of the papers on this subject had been presented.

Mr. E. P. Felt then presented the following paper:

EXPERIMENTAL WORK IN NEW YORK STATE AGAINST THE SAN JOSE SCALE.

By E. P. Felt, *Albany, N. Y.*

The apparent complete destruction of the San Jose scale following the spraying operations of the writer last December is in marked contrast to some results obtained in other sections of the State. The work was done December 11, 1901. The day was an ideal one, there being very little or no wind most of the time and the temperature ranging from about 30° F. in the shade to 68° in the sun. The trees were dry, and, despite the fact that there had been considerable cold weather and much snow the previous week, even the very bases of the trunks of the trees were exposed and dry and the insecticides could therefore be applied to the greatest advantage. The sun shone brightly most of the day, and it was one which would be characterized as a drying day. The apple orchard, where most of the work was done, consisted of over 60 young trees, many of which were in an exceed-

ingly bad condition on account of the abundance of the San Jose scale and a number were badly infested by the round-headed apple-tree borer.

A 20-per-cent mechanical emulsion of a light, crude petroleum (41.1° Beaumé), obtained from the Derrick Oil Company, was applied to 22 apple trees and to 14 plum, pear, and quince trees. Examinations this spring, even as late as June 12, showed that the apple trees had apparently suffered little or no injury from the insecticide. These trees are not in good condition this spring, but this is due almost entirely to serious injuries inflicted by the two insects above named. The Clapp's Favorite pear trees were injured somewhat, several limbs being killed, the bark cracking in places and some suckers being thrown out. The Dutchess pear trees suffered less and the Bartlett's apparently escaped without any injury, being in excellent condition and two of them bearing considerable fruit. The tips of a number of limbs on a Globe peach tree were all dead this spring, but this can not be attributed to the insecticide, as some untreated trees suffered in the same manner. The treatment may, however, have facilitated winter killing. Several Meeche's Prolific quince trees were also sprayed, without the slightest deleterious effects being observed.

Good's potash whale-oil soap No. 3, two pounds to the gallon, was applied on the same day to 23 apple trees and 10 pear, plum, cherry, and quince trees. The Clapp's Favorites, Bartlett's, Beurre d'Anjou, and Vermont Beauty pear trees suffered no injury and bear some fruit. A yellow gage plum has no fruit and a Magnum Bonum plum bears considerable. Both trees are in excellent condition and evidently suffered very little or no harm from the insecticide, unless the fruit buds of the first-named variety were killed, which is hardly probable.

Good's tobacco whale-oil soap No. 6, two pounds to the gallon, was also tested under the same conditions on 10 apple trees and 18 green gage plum trees. The apple trees showed very little or no injury, while most of the plum trees have suffered harm, which is shown by the majority developing a considerable number of adventitious shoots.

Two small apple trees were painted with linseed oil, the raw product being used on one and the boiled on the other. The first was killed outright by the application and the second nearly so. This substance is so dangerous that its use in the fall can not be recommended.

All of these applications have, so far as present examinations can determine, given most excellent results so far as insecticidal purposes are concerned. Many of the trees were very badly encrusted with the San Jose scale and apparently not a single scale has survived the treatment. This statement may need modification as the breeding season advances, but the present indications are very satisfactory indeed.

REPORT OF EXPERIMENTS WITH LIME, SALT, AND SULPHUR WASH AGAINST THE SAN JOSE SCALE IN MARYLAND.

By A. L. Quaintance, *College Park, Md.*

As a result of experiments by the entomologists of the Division of Entomology, United States Department of Agriculture, and others, it has perhaps been generally accepted that the lime, salt, and sulphur wash, so effective in California against the San Jose scale, is of comparatively little value in the East, owing to our more rainy climate. In the past few years, however, numerous reported cases of its successful use have awakened renewed interest in the wash, and further experiments have seemed desirable, particularly in connection with a record of weather conditions, which seem to be an important factor in the results following its application.

The past winter applications of the lime, salt, and sulphur wash were made in three different localities in Maryland, namely: College Park, Prince George County; Annapolis Junction, Howard County; and Sharpsburg, Washington County.

Experiment I.—At College Park, 20 five-year-old Japan plum trees, badly infested with scale, were treated on March 4. A Pomona barrel sprayer was used, fitted with Seneca nozzles. The wash was made according to the following formula:

Lime	pounds..	40
Salt	do....	15
Sulphur	do....	20
Water	gallons..	60

The sulphur and 20 pounds of quicklime were placed in a barrel with 20 gallons of water and steam cooked for one and one-half hours, after which the salt and the remaining lime were added and the whole cooked for one-half hour longer, after which the balance of the water was added.

At the time of making the application the weather was cloudy, and the temperature ranged somewhat above the freezing point all day. Soon after the work had been finished a light snow began to fall, which alternated with rain and sleet during the night and most of the following day. The trees were wet almost continuously for a period of twenty to twenty-two hours immediately following the application of the wash. Several succeeding days were clear and bright, with the temperature ranging mostly above the freezing point. The precipitation and aspect of sky from March 4 to May 31 is given in the following table, as taken from the weather record book of the United States Weather Bureau, as recorded by Prof. W. T. L. Taliaferro at the experiment station, about one-fourth mile from the treated trees:

Record of weather from March 4, 1902, to May 31, 1902, in connection with lime, salt, and sulphur experiment at College Park, Md.

Date.	Precipitation.	Character of weather.	Date.	Precipitation.	Character of weather.
	Inches.			*Inches.*	
March 4	1.07		April 26	0.31	
5	.41		27		Clear.
6–11		Clear.	28	.14	
12	.34		29	.19	
13	Trace.		30		Clear.
14–15		Clear.	May 1		Clear.
16	.29		2	.41	
17–27		Clear.	3–6		Clear.
28	.71		7	.09	
29–30	.31		8–10		Clear.
31		Cloudy.	11		Part cloudy.
April 1		Cloudy.	12		Clear.
2–3		Cloudy	13	.03	
4	.06		14–17		Clear.
5–6	.05		18		Part cloudy.
7	1.10		19	.33	
8	.40		20	.19	
10		Part cloudy.	21–22		Clear.
11–13		Clear.	23	.64	
14	Trace.		24–25	.69	
15		Cloudy.	26	.32	
16		Part cloudy.	27		Part cloudy.
17		Clear.	28	Trace.	
18	Trace.		29–31		Clear.
19–25	Trace.	Clear.			

As will be noted in the table, there were 1.48 inches precipitation on the night and succeeding day following the application. There was a light rain of 0.34 inch on March 12, eight days after date of application. A light rain also occurred on the 16th, and 0.71 inch fell on the 28th, with a precipitation of 0.31 inch during the 29th and 30th. There was thus a total precipitation from March 4 to 31 of 3.13 inches. During April rain fell at seven different times, with a total for the month of 2.25 inches. During May rain fell on eight different dates, with a total of 2.70 inches.

Frequent examinations of the treated trees were made to note the effect of the wash on the scales. The earlier examinations indicated that a very large percentage of the scales had been killed. Later examinations, however, showed that these estimates had been placed too high, and in the final examination, on June 2, of many branches and twigs from different trees the percentage of scale killed was placed at from 55 to 60 per cent. At this time the young lice were very abundant, many having settled on the limbs, leaves, and fruit. Scraping the infested branches with a knife revealed the bright, yellow bodies of the mature females in great numbers, and running the blade flatwise pressed out an abundance of oily fluid from the scales.

On the whole, the treatment was far from satisfactory, and was not sufficiently so to render the use of the wash profitable in comparison with some of the other insecticides used against this species.

Experiment II.—The test at Annapolis Junction was made on an orchard of 225 ten-year-old apple trees and about 50 two-year-old peach trees. There was a general sprinkling of the scale throughout the orchard, and many trees were quite badly infested, the trunk and limbs being mostly incrusted with scale. The wash as made up was identical with that used at College Park, but was cooked in a large iron boiler instead of in a barrel by the use of steam. The wash was applied with the same apparatus, and when finished the trees were quite thickly and uniformly coated with the mixture. The treatment was made on March 27 and 28, the weather being clear, with but little wind. The following weather record as furnished me by Col. W. S. Powell, on whose farm the work was conducted, is of interest in this connection:

March 29. Warm, with showers in afternoon.
March 30. Showers in afternoon.
March 31. Snow and rain; cold winds.
April 1. Cold winds.
April 2. Cold winds.
April 3. Fair.
April 4. Light rain.
April 5. Fair.
April 6. Light rain.
April 7. Cloudy.
April 8. Driving rain all day.
April 9. Light rain.
April 10. Fair and cold.
April 12. Fair.
April 13. Fair and windy.
April 14–28. Fair, with variable temperature.
May 6. Fair, with variable temperature.
May 7. Rain during night.
May 8–12. Fair.
May 13. Rain in afternoon.

The weather record was not kept after May 13, as later than this it was not considered as having any bearing on the experiment.

A careful examination of infested twigs from different trees on May 10 led to the conclusion that a considerably higher percentage of scale had been killed than a subsequent examination on June 13 proved to be the case. On this date many young scales were crawling, and very many live scales were exposed by scraping the infested limbs with a knife. After an examination of many trees, both peach and apple, the percentage of dead scale was placed at from 45 to 50.

In considering the weather record for this test, it will be observed that rain fell on the three days succeeding the application, and on

April 8, eleven days after the treatment, there was a driving rain all day. Rain fell in varying amount at eight different times during the course of the thirty days following the application of the wash.

A slight variation was made in the treatment applied to two rows of apple trees, which might here be mentioned. These trees were sprayed with the usual lime, salt, and sulphur wash, to which refined glue had been added at the rate of 3 pounds to the barrel of water. An appreciable difference in the effectiveness of this wash was to be noted, an increased percentage of scale of not less than 18 or 20 per cent having been killed.

In the foregoing tests the results were decidedly disappointing, so far as the effectiveness of the wash was concerned, but considered in connection with the weather conditions which prevailed it is not likely that applications of other insecticides would have given anything like usual results.

Experiment III.—The third test of the wash was made in an orchard of 5-year-old peach trees on the farm of Mr. S. S. Stouffer, Sharpsburg, Md. A block of about 50 trees was selected and treated with the wash on March 22, the day being bright, warm, and calm. Two formulæ were used, the 40-15-20 to 60 gallons of water, and the 30-8-12½ to 50 gallons of water. The rains which occurred, as reported by Mr. Frisby Smith, who also applied the spray, are as follows:

March 28. Light rain.
April 8 and 9. Heavy rain.
May 19. Heavy thunder storms.
May 25. Heavy thunder storms.

The trees in this plat were examined June 19, and the results were quite different from those previously recorded. Live scales were quite hard to find, although some trees were rather badly infested with them. On the whole, the percentage killed was placed at from 98 to 99 per cent. No appreciable difference was to be noted in the results from the different formulæ. The trunks and larger limbs were still coated with the wash, so that the scales were considerably obscured.

The lime, salt, and sulphur wash was used by Mr. Stouffer one year ago this spring on a part of his orchards with gratifying results, and his entire orchard was sprayed with it the present spring. Three years ago the scale was very serious in this orchard, some trees having been killed and many seriously injured. At the present time the insect is under complete control, and no fear is now felt as to the possibility of keeping it in check with this treatment.

SOME PRACTICAL EXPERIMENTS WITH VARIOUS INSECTICIDES FOR THE SAN JOSE SCALE IN GEORGIA.[a]

By W. M. Scott, *Atlanta, Ga.*

The Georgia State department of entomology was established in March, 1898, and at that time, as shown by inspections made later, the San Jose scale had become established in 57 counties, including the leading orchard sections of the State. No system of treatment had been adopted, most of the owners of infested orchards not having even determined the cause of the trouble.

In a few instances, however, some knowledge of this pest and its treatment had been gained through correspondence with the Division of Entomology and the Georgia Experiment Station. In the Tifton section some 50,000 peach trees had been subjected to the gas treatment, and whale-oil soap was being used quite extensively in Randolph County, but as a rule practically nothing was being done to control this pest. The gas treatment, although giving good results, proved to be too cumbersome, and the soap washes, owing perhaps to lack of thorough application, were unsatisfactory.

Our State law was such as to compel the treatment of infested orchards, and it was incumbent upon the newly appointed entomologist to furnish the remedy. After some preliminary experiments the oil-water treatment was adopted and a 25 per cent strength of kerosene was recommended for the winter of 1898–99. The results were generally satisfactory, but it was found advisable to reduce the strength to 20 per cent. Experiments with crude petroleum, made the following year, gave this substance the preference, better results being obtained with it than with corresponding strengths of kerosene. For several years, therefore, kerosene and crude oil in mechanical mixture with water have been very extensively used against the San Jose scale in Georgia, and, though on the whole successful, there have been several cases of more or less serious damage to the treated trees. In most cases the damage has been accurately traced to some defect in the pump, carelessness in the application, or other causes within the power of the orchardist to control. But there have been a few cases where the resulting damage could be attributed to no fault of the operator. These adverse results gave rise to some distrust of the oil sprays, which was augmented by the arguments of certain vendors of sure-cure washes and compounds guaranteed to exterminate the scale without damage to the trees.

In order to test these "cure-all" compounds and other better known scale washes in comparison with the oils officially recommended by

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[a] For valuable assistance in the execution of these experiments the writer is indebted to Mr. W. F. Fiske, who personally conducted the larger portion of the work with the soaps and caustic washes; and to the owners of the orchards, who furnished the teams and labor.

the Department, a series of extensive experiments was planned, for the execution of which an orchard of 17,000 2-year-old peach trees was secured from Mr. S. H. Rumph, at Marshallville, Ga. In addition a near-by orchard of Mr. F. J. Frederick's, consisting of about 2,000 4-year-old peach trees was used, more particularly as a test of the insecticides upon bloom buds.

The larger orchard was divided into plots of 400 trees each, and these were so arranged that each plot contained five or more varieties of peaches. The orchard was badly infested with the San José scale, less than 10 per cent of the trees being entirely free, and from 10 to 40 trees in each plot being either completely encrusted or nearly so. The orchard became infested from local spread during the first season after planting, and until the experiments were begun in November, 1901, it had received no treatment.

In the Frederick orchard some scales were found on every tree, and about 25 per cent of the trees were quite badly infested.

The following substances were used in the experiments:

Oils:
- Pennsylvania crude, 43° gravity.
- Refined kerosene, 150° flash test.
- Standard Oil Company's fuel oil.
- California distillate.

Soaps:
- Leggett's Anchor brand.
- Leggett's whale-oil soap compound.
- Good's No. 3.
- Good's No. 6, tobacco.
- Turpentine soap.

Caustic washes:
- Lime, sulphur, and salt wash.
- Crude potash.
- Resin wash.
- Carbolic acid emulsion.

It should be explained that during the course of the winter a large number of the scales perish without treatment. The females that have reached maturity and commenced breeding rarely survive the winter. In making up results, therefore, only the immature overwintering individuals were counted.

PETROLEUM OILS.

Owing to delay in obtaining the crude oil no comparative tests were made until January 15, when the work with oils was properly begun. From that date applications were made at various intervals until March 7, at which time the fruit buds were beginning to part their petals. During the first week in December, however, kerosene in soap emulsion was used at strengths of 10, 15, and 20 per cent.

Nearly all sorts of weather conditions were met with, and an excel-

lent opportunity was thus afforded for testing the influence of the weather upon the effect of the oil sprays. Applications were made on fair and cloudy days, immediately before and after rains, early mornings, and late afternoons. Peculiarly enough, however, the different conditions attending the various applications made no apparent difference in the effect of the oil upon the trees or scale insects; likewise no appreciable difference in the results could be detected between early and late applications. This was rather surprising, as it was expected that applications followed within a few hours by clouds and rain would result in damage to the treated trees.

No attempt is made to record the details of these experiments here. Below some of the tests are summarized in a general way. Applications having been made at different seasons and under different weather conditions, a large number of plots were required and many of these could not be included in the tables.

Crude petroleum.—A summary of the applications and results in the Frederick orchard is given in Table I. It is not deemed necessary to give a similar table of the work in the Rumph orchard which, though on a much more extensive scale, does not give results materially different from those contained in this table. It is worthy of note, however, that the trees in the Rumph orchard received no apparent damage from any strength of oil applied, while some injury was noted in the Frederick orchard, attributable in part to defects in the pump and possibly to some extent to the condition of the trees, the Rumph orchard not having yet come into full bearing.

TABLE I.—*Results from applications of crude petroleum.*

Number of trees.	Age.	First application.		Second application.		Date of final examination.	Effect on scale.	Effect on trees.	General notes.
		Date.	Strength and form.	Date.	Strength and form.				
175	4 years..	Jan. 17	15 per cent in mechanical mixture.	.....	.....	Apr. 16	Less than 1.5 per cent alive.	None, or at most very slight.	Cloudy, and trace of rain on following day (Jan. 18).
25	....do...	....do...	.....do.....	Mar. 7	15 per cent in mechanical mixture.	....do...	Estimated 2 per cent alive.	None.....	Mar. 7 fair and bright; slight precipitation on the 8th.
175	....do...	Jan. 18	20 per cent in mechanical mixture.	.....	.....	....do...	Estimated less than 0.5 per cent living.	8 trees injured, none fatally.	The damage was caused by imperfection in working of pump. All injured trees in these two plats adjacent.
25	....do...	....do...	.....do.....	Mar. 7	20 per cent in mechanical mixture.	....do...	.....do.....	12 trees more or less injured—some only slightly, none fatally.	
175	....do...	Jan. 20	15 per cent in mechanical mixture.	.....	.....	....do...	No live scale found..	4 trees injured, 2 severely.	Day fair, followed by 0.75 inch rain at night.
25	....do...	....do...	.....do.....	Mar. 7	25 per cent in mechanical mixture.	....do...	Estimated 3 per cent live scale found.	Very slight.....	High percentage of living scale due to portion of twig missed by spray.
175	....do...	Jan. 24	15 per cent in soap emulsion.	.....	.....	Apr. 17	Estimated 7 per cent live scale found.	Very slight, or none at all.	Portions of limbs on 2 trees found not hit by spray.
25	....do...	....do...	.....do.....	Mar. 7	15 per cent in soap emulsion.	....do...	Estimated 0.5 per cent live scale.	None.....	Jan. 24 cloudy, with trace of rain.
175	....do...	....do...	20 per cent in soap emulsion.	.....	.....	....do...	Less than 0.5 per cent of live scale.	.....do.....	
25	....do...	....do...	.....do.....	Mar. 7	20 per cent in soap emulsion.	....do...	No live scale found out of 1,100 counted.	.....do.....	
175	....do...	....do...	25 per cent in soap emulsion.	.....	.....	....do...	No live scale found out of 450 counted.	.....do.....	
25	....do...	....do...	.....do.....	Mar. 7	25 per cent in soap emulsion.	....do...	No live scale found out of 500 counted.	.....do.....	

Considering the effect upon both the scale insects and the treated trees, the results were slightly in favor of crude oil applied in the form of emulsion with soap at the strength of 20 or 25 per cent. In many cases 25 per cent oil gave no better results than a 20 per cent strength, the latter proving sufficient to destroy all scales with which it came in contact. Moreover, it was found unnecessary to make more than one application, although the second application doubtless killed some insects that were not reached by the first. No apparent damage to the trees or fruit buds could be definitely attributed to the emulsion. Trees that received two applications of a 25 per cent strength showed little or no ill effect.

Equally as good results were obtained from crude oil applied with the mechanical mixing pumps when a uniform discharge could be obtained. The Gould "kero-water" pump with two 20-foot leads of hose was used and, though apparently the best pump of this nature on the market, it can not always be depended upon for a uniform percentage of oil. For some unexplainable reason the discharge of either oil or water may cease at varying intervals; and even if this regularity lasts only for a moment, a tree may be seriously injured or the scale infesting it may escape unharmed. Moreover, owing to the construction of the pump, a slightly greater percentage of oil is usually discharged through one lead of hose than the other; and with nozzles having small apertures (one-twentieth inch Vermorel were used) there is always some separation of the oil and water in the hose and consequent variations in the composition of the spray from one instant to another. However, it should be explained that with constant care and frequent tests excellent results can be obtained by the use of these pumps. In the experiments no great difficulty was encountered and, with the exception of a very few injured trees and lack of effect on the scale in rare cases, the results compare favorably with those obtained from the soap emulsion.

Kerosene.—What has been said of the comparative value of crude oil in mechanical mixture and in soap emulsion applies equally well to kerosene, the latter form of application giving slightly more uniform results in both cases. The results from a portion of the plats treated with kerosene are contained in Table II, which is made from notes on the early applications of emulsion in the Rumph orchard and later applications of the mechanical mixture in the Frederick orchard.

TABLE II.—*Results from applications of kerosene.*

Number of trees.	Age.	First application.		Second application.		Date of final examination.	Effect on scale.	Effect on trees.	General notes.
		Date.	Strength and form.	Date.	Strength and form.				
175	4 years..	Jan. 20	15 per cent in mechanical mixture.	.....	.....	Apr. 17	Estimated less than 1 per cent living scale.	None ...	Day fair, followed by 0.75 inch rain at night.
25	....do ...	....do ...	.....do	Mar. 7	15 per cent in mechanical mixture.	....do ...	Estimated 3 per cent living	....do ...	The living scale in this plat found on incrusted trees.
175	....do ...	Jan. 23	20 per cent in mechanical mixture.	.....	.....	....do ...	Less than 1 per cent living scale.	....do ...	
25	....do ...	....do ...	.....do	Mar. 7	20 per cent in mechanical mixture.	....do ...	1 per cent living scale	....do ...	All live scale found were on underside of one limb.
175	....do ...	....do ...	25 per cent in mechanical mixture.	.....	.....	....do ...	Less than 1 per cent live scale.	....do ...	
25	....do ...	....do ...	.....do	Mar. 7	25 per cent in mechanical mixture.	....do ...	Less than 1 per cent live scale.	....do ...	Mar. 7 fair, followed by slight rain on 8th.
100	2 years..	Nov. 30	10 per cent in soap emulsion.	.....	.....	1st week in May.	10 per cent live scale	....do ...	Strength clearly insufficient.
200	....do ...	....do ...	.....do	Feb. 24	15 per cent in soap emulsion.	....do ...	Estimated 3 per cent living scale.	....do ...	Weather fair on Nov. 30 and the day following.
100	....do ...	....do ...	.....do	....do ...	20 per cent in soap emulsion.	....do ...	0.1 per cent alive	....do ...	
100	....do ...	....do ...	15 per cent in soap emulsion.	.....	.....	....do ...	3 per cent alive.....	....do ...	
200	....do ...	....do ...	.....do	Feb. 16	15 per cent in soap emulsion.	....do ...	3 per cent still living	....do ...	Feb. 16 very windy, and on that account spraying discontinued.
100	....do ...	....do ...	.....do	....do ...	20 per cent in soap emulsion.	....do ...	Only a few crawling young found.	....do ...	
100	....do ...	Dec. 4	20 per cent in soap emulsion.	.....	.....	....do ...	Less than 1 per cent live scale.	....do ...	Dec. 4 fair, followed by cloudiness and 0.08 inch rain on 5th.
125	....do ...	Feb. 17	10 per cent kerosene in emulsion added to a 4 per cent emulsion of crude carbolic acid.	.....	.....	....do ...	15 per cent living scale.....	.....	Addition of carbolic acid of no avail.

At strengths of 20 and 25 per cent the results, on the whole, were quite satisfactory and such as to warrant one in continuing to recommend the use of kerosene (preferably in soap emulsion) for scale-infested orchards in Georgia, when crude oil can not be conveniently procured. The crude oil is cheaper and in practice appears to be considerably more efficient, owing to the residuum with which the trees remain coated for weeks after the application.

Fuel oil.—This substance was purchased from the Standard Oil Company with the intention of using it cautiously on only a few trees. On February 18, it became necessary to leave the work for a day in charge of the foreman, a white man, who was given explicit instructions for carrying out the experiment with crude oil in mechanical mixture. Through mistake he got hold of the fuel oil and very carefully carried out the scheme of experiments, thinking that he was using the high-grade crude oil. It was applied to about 1,000 trees in the Rumph orchard. Unfortunately the entire lot was used up before the mistake was discovered and no record was made of its specific gravity. It was applied at the rate of 10, 15, and 20 per cent as a first application and at the same strengths as a second application where the high-grade crude oil had been used a month before in corresponding strengths.

The results were quite surprising, in that the trees suffered no apparent damage even where the 20 per cent strength followed as a second application upon the high-grade oil. Some of the treated trees were slightly backward in putting out foliage, but they soon became vigorous and all indication of injury disappeared. The effect upon the scale was as good as that obtained with the high-grade oil. The 20 per cent strength killed more than 99 per cent of the scale and the 15 per cent strength appeared to be equally as effective, while at 10 per cent the vagaries of the pump became apparent in the results.

Distillate emulsion.—Ten gallons of this substance was obtained from California and used as recommended in that State. It was found that a strength of 1 part of the emulsion to 4 parts of water was required for efficient work against the scale. The results from weaker applications were unsatisfactory. The effect upon the treated trees was slightly injurious, but in no case seriously so.

SOAPS.

All the brands of soap mentioned above were tested more or less extensively, and to record the results from each would require too much space here.

The earlier applications (beginning December 2), except in the case of one brand of soda soap, were generally unsuccessful, owing, in part at least, to adverse weather conditions immediately following. The last series of tests (made March 6) were quite satisfactory, less than

1 per cent of live scale remaining on trees treated with a solution containing 2 pounds to each gallon of water. One and one-half pounds to the gallon, though killing much the larger portion of the insects, was notably less effective. Rain within twenty-four hours after treatment seriously interfered with the results, particularly when a potash soap was used. In one case 1½ pounds to the gallon was more effective than 2 pounds to the gallon applied the following day, both applications having been drenched with rain on the third day.

One hundred or more trees were used in each test, and the general effect (aside from that upon the scale) appeared to be more beneficial than otherwise. Some damage to fruit buds, not, however, of a serious nature, resulted from the early December applications. The spring work gave no ill effect.

CAUSTIC WASHES.

Lime, sulphur, and salt.—Three strengths of this wash were used, the standard formula (30 pounds of lime, 20 of sulphur, and 15 of salt) being diluted to 40, 50, and 60 gallons. It was applied at four different dates, February 28, March 3, 6, and 7.

February 28 was a fair day, with a slight breeze from the southwest during the forenoon, freshening into a brisk wind in the afternoon, rendering thorough work difficult. On March 1, 1.33 inches of rain fell, but the temperature (maximum, 58° F.; minimum, 33°) was cold for the season. On March 5, 0.23 inch of rain fell, followed by two fair days and a slight rain (0.02 inch) on the 8th. No more rain fell until March 14, when it commenced and rained through the 16th, during which time the precipitation amounted to 4.75 inches.

The more thorough observations were made during the first week in May, when it was found that the best results were obtained from the applications on March 3 and 6, which killed about 90 per cent of the scale. On the other plots as much as 20 per cent of the scale could be found alive. However, a more hasty examination, made June 4, showed that the insects were still dying and that before the wash should be exhausted the fatality would be much greater than the earlier observations indicated. The scaly covering of such insects as appeared to be alive were in many cases so corroded by the wash as to afford little protection to the insects. Contrary to expectation, the strongest solution gave no better results than those of greater dilution.

It might be said that the results upon the whole were somewhat gratifying and that further tests may prove the lime, sulphur, and salt wash to be a valuable scale remedy for Georgia. In the light of later knowledge it is quite certain that our method of preparation could be improved upon, as it now appears that some of our poor results were probably due in part to insufficient boiling.

Crude caustic potash.—Crude caustic potash in solution was used at strengths of 1, 2, and 3 pounds to 10 gallons of water. The first application (made in the fall) was of the medium strength, with results far from successful, owing perhaps to wet weather immediately following. The second spraying, March 6, gave the following results as shown by examination made May 6:

1 pound to 10 gallons, 25 per cent of scale alive.
2 pounds to 10 gallons, 3 per cent of scale alive.
3 pounds to 10 gallons, less than 1 per cent of scale alive.

No injury to the trees resulted, but the stronger solutions cut the hose very badly. It is clear, then, that potash used strong enough will successfully destroy the scale, but it is quite impractical to use it extensively at the required strength owing to its caustic effect upon both the hose and the operators.

Resin wash—One application prepared according to the standard formula was followed by no good results.

Carbolic acid emulsions.—Three different washes, of unknown composition, but consisting essentially of an emulsion of crude carbolic acid with varying proportions of oils, soap, and other ingredients, were given thorough trials. It was found that less than a 16 per cent strength of any of these washes was practically ineffective, and though 20 and 25 per cent strengths were reasonably effective, the cost would debar their use.

PRACTICAL WORK IN A LARGE ORCHARD.

In addition to the regular experiments, an orchard of 55,000 three-year-old peach and 1,000 plum trees belonging to Mr. W. C. Wright, of Fort Valley, Ga., was treated under the writer's supervision. Mr. Wright was very much alarmed over the condition of his orchard, and he made a special request of the entomologist to assume full control of its treatment.

Beginning August 8, 1901, the orchard was given an inspection row by row, which revealed 1,000 badly infested trees well distributed. From these centers of infestation the scale had spread generally in all directions, leaving only a small percentage of the trees entirely free. Beginning August 20, all the badly infested trees that had been located were sprayed with a 10 per cent strength of kerosene, using a knapsack "kero-water" pump. This checked the breeding of the scale, and was apparently the means of saving a large number of trees that would doubtless have perished before time for winter treatment.

From December 25 to January 2 each badly infested tree and with 15 or 20 adjacent trees were sprayed with a 15 per cent strength of kerosene, using a barrel pump. In this manner the 1,000 trees representing the centers of infestation had received two applications of oil

(10 per cent and 15 per cent, respectively) and about 1,500 trees one application before the general treatment of the orchard commenced.

It was intended that the entire orchard should be treated with crude petroleum, but delay in obtaining this substance necessitated the continuation of the use of kerosene. Taking the trees in regular order, regardless of previous treatment, 17,000 were sprayed with a 20 per cent strength of kerosene between January 3 and 23. The crude oil had then arrived, and from January 25 to February 7 28,000 peach and 1,000 plum trees were sprayed with a 20 per cent strength of this substance, which registered 43½° gravity on the Beaumé oil scale. The remaining 10,000 trees being detached from the main orchard and containing only a slight infestation of scale, were not taken into account in making notes. However, they were sprayed with a 20 per cent strength of kerosene, beginning February 11. The effect of the treatment was carefully watched, and at the end of three weeks after 20 per cent kerosene had been applied to the block of 1,700 trees in the general treatment, a small percentage of live scale insects could here be found. It was then too early to make a definite determination of the results, but the owner was not satisfied with the indications and the writer consented to another application to this block, advising 15 per cent kerosene, which was applied late in February.

Reviewing the treatment, a portion of the 1,000 badly infested trees was sprayed four times at different periods with kerosene at 10, 15, 20, and 15 per cent strengths, respectively, and the remainder three times with 10 and 15 per cent strengths of kerosene, respectively, followed by a 20 per cent strength of crude oil. A portion of the 15,000 trees that received 15 per cent kerosene before the general treatment commenced was sprayed with 20 per cent kerosene in January, followed by an application of 15 per cent kerosene late in February, while the other portion received a 20 per cent strength of crude oil. Then a portion of the trees that remained unsprayed when the general treatment commenced received a 20 per cent strength of kerosene, followed by a 15 per cent strength, while the other portion received a 20 per cent strength of crude oil only.

The entire work throughout the season was done in the most careful manner possible on a large scale. Six Gould barrel "kero-water" pumps were used, and these were supplied with oil by extra teams while the water was piped into the orchard. The work was done with negro labor, superintended by the owner of the orchard and two intelligent white men, who at short intervals tested the percentage of oil discharged and saw that every portion of the tree was moistened with the spray. When any part of the tree was found dry it was resprayed, even at the cost of turning the team. By the employment of a mechanic the pumps were kept so adjusted as to do satisfactory work.

The results were beyond expectation. When the winter work was

begun the new double-hose arrangement by which the oil and water are kept separate until the nozzle is reached was employed. Instead of producing a mechanical mixture, pure oil and pure water were alternately discharged. On one morning in trying to start five pumps with these attachments a number of trees were sprayed with pure kerosene, resulting in the death of 40. The new style attachment was discarded, and no more injury was done save possibly the death of about 50 other trees which may be attributed to the combined effect of the scale and the treatment. The trees bloomed and leaved out normally, and are now bearing a magnificent crop of fruit.

The scale was as nearly eradicated as the writer believes possible with any treatment. During the course of spring and summer until June 17, when the last observations were made, the writer visited the orchard three times and carefully examined several hundred trees both in the kerosene and crude oil blocks, and found only two trees bearing live scales. These were located in one of the kerosene blocks where two applications had been made. A general inspection of the orchard on June 17 revealed no further infestation of living scales. It is understood, of course, that should every tree in the orchard be carefully examined a large number would no doubt show some living scales, but the observations have been sufficiently extensive to warrant the statement that better results can rarely be obtained with any practical treatment.

SOLUBLE ARSENIC IN ARSENICAL INSECTICIDES.

By J. K. Haywood, *Washington, D. C.*

Chief of insecticide and agricultural water laboratory, Bureau of Chemistry, U. S. Department of Agriculture.

The two insecticides to which I chiefly desire to call attention are Paris green and London purple. As is well known, Paris green is composed of copper oxid, acetic acid, and arsenious oxid, which are all combined to form copper-aceto-arsenite, in the following proportions:

	Per cent.
Copper oxid	31.29
Arsenious oxid	58.65
Acetic acid	10.06

Since this is a commercial article, small amounts of foreign matter are always present. Among these may be mentioned sodium sulphate, sand, and arsenious oxid, the last of which is not combined as it should be with the other two constituents, but is present in the free state. It is this arsenic which is generally supposed to scorch foliage when applied in too large amounts.

In California, and in the East generally, 4 per cent free arsenious oxid has been adopted as being the maximum amount allowable in Paris

green, the free arsenic being determined by dissolving it from the Paris green by means of distilled water.

What I desire to call attention to here is that there may be three conditions giving rise to a scorching of the foliage by the use of Paris green:

(1) As I have already said, there may be a certain amount of arsenious oxid in the Paris green over and above that combined with the other constituents. This is called "free" arsenious oxid, and has until recently been considered as the only cause for the scorching of foliage by Paris green.

(2) A number of Paris greens now on the market are poorly made, and when brought in contact with water, especially water charged with carbon dioxid, readily break up in the course of a short time, arsenious oxid being set free in the process. This is true to some extent even of the best Paris greens, but the poorly made ones break up much more quickly and readily. Let us see, then, what the effect of such greens would be upon the foliage. They would, in most cases, be sprayed upon the leaves while suspended in water. The water, along with the carbon dioxid of the air, would immediately commence to set arsenious oxid free. Not only would this go on with the original water, but the rain and dew that collect upon the plant would carry the process still further, and in the case of a poorly made article there would soon be enough free arsenious oxid to seriously scorch the foliage. Of course this change would go on in the case of well-made Paris greens, but so slowly that unless the climatic conditions were very adverse not enough arsenious oxid would be present at any one time to do any serious damage.

(3) It is a well-known fact that even the best Paris greens, when ground to a very fine powder and applied to the foliage, will scorch. This seems to be due to the fact that the fine grinding exposes more surface to the action of water (and water charged with carbon dioxid), and that consequently the decomposing action of the water on the Paris green is accelerated and enough free arsenious oxid soon gathers to do serious damage.

It appears, then, that there are three conditions of Paris green that may give rise to free arsenious oxid and consequent scorching, and what confronts the chemist is the discovery of a method or methods by which he can tell how much free arsenious oxid is actually present in a sample of Paris green, or how much, because of its condition, may be set free in a short length of time.

This is rather a hard problem and, from the nature of the case, only an arbitrary method can now be proposed or expected.

Manifestly it would not do to extract the sample for twenty-four hours with water since, in this length of time, even where free arsenious oxid is present as such, it does not all go into solution nor does

a badly made or very fine Paris green decompose to a great extent in this length of time. It has been found by the author that it takes nearly ten days for all free arsenious oxid in Paris green to go into solution. It has also been found that badly made Paris greens are broken up enough during the course of ten days to show whether they are very unstable or not and that well-made Paris greens are not broken to a great extent in this length of time. Avery and Beans[a] have found that at the end of ten days a finely powdered article has been broken up to a great extent. It has therefore been thought best to determine the soluble arsenious oxid in Paris green by extracting 1 part with 1,000 parts of water (free from carbon dioxid) for ten days and at the end of this time determine the arsenious oxid in an aliquot portion of the filtrate. This method does not distinguish between the three causes of the soluble arsenious oxid, but it is undoubtedly true that all three are bad, although very likely not equally so. Other work done by Avery and Beans distinguishes to a certain extent between free arsenious oxid as such and the other two forms, so that at least we can say whether the soluble arsenious oxid is due to free arsenious oxid on the one hand or badly made or fine Paris greens on the other.

Since these three distinct types of soluble arsenious oxid have not been previously recognized, and since, when 4 per cent was adopted as the maximum limit of soluble arsenious oxid allowable in Paris green, a much shorter time of extraction with water was used than ten days (resulting in much lower figures for soluble arsenious oxid), it appears to the author that work along this line is needed badly, work that will determine the maximum percentage of soluble arsenious oxid that can be present in Paris green without scorching in each of the three forms, or as many of these forms as our present chemical methods will enable us to recognize.

The Bureau of Chemistry, U. S. Department of Agriculture, in collaboration with the Division of Entomology, is now carrying on preliminary work of this character, but in order to make the work a success each of the States will have to take it up, it being well known that climatic conditions markedly influence the amount of free arsenious oxid that a plant can stand. I therefore lay this matter before you with the hope that entomologists from the various States may be interested enough in the work to collaborate with us during the coming spring. The Department will prepare all samples and send them out and the various entomologists will do the spraying, for which full credit will be given in each case.

The second class of insecticides to which your attention is directed are the London purples. These are prepared by boiling an analine dye residue containing arsenic with lime. Up to a very recent date

[a] Jour. Amer. Chem. Soc., Vol. XXIII, No. 2.

London purple was supposed to consist of an organic dye residue and calcium arsenite, but work which the author has carried on shows that it consists of an organic dye residue, calcium arsenite, and calcium arsenate.

While the relative quantities of the two last-mentioned substances vary a great deal, the total amount of metallic arsenic is nearly the same in all samples examined.

According to the old way of examining London purple, a portion was extracted with water and the soluble arsenious oxid determined in the solution. Where this was low the sample was passed as good and was used in spraying. Since it has been found, however, that arsenic oxid is also present, this must also be determined in the soluble portion. Proceeding in this way, it was found that whenever the soluble arsenious oxid was low the soluble arsenic oxid was high, and vice versa, so that in every sample examined the total amount of arsenic going into solution was very high, much higher, in fact, than the maximum limit of 4 per cent that has been previously recognized. Following are examples of three representative samples:

	Soluble arsenious oxid.	Soluble arsenic oxid.
	Per cent.	*Per cent.*
1	2.43	15.81
2	13.49	7.12
3	1.44	19.56

It is a well-known fact that although London purple has gone out of use to a great extent now because of its scorching the foliage, it has been used and is used in many cases with excellent results. The only conclusion we can come to from the above facts is that many plants, under certain conditions at any rate, can stand a vast amount more of soluble arsenic than has been previously supposed. Of course, if this arsenic were present as the free acid it would undoubtedly kill or defoliate the tree; but its being present, as it is in London purple, as the calcium salts of arsenious and arsenic oxid evidently has a strong modifying influence.

Compounds of this class are also being studied by the Bureau of Chemistry and Division of Entomology and, just as in the case of Paris green, the cooperation of the various States is absolutely indispensable to the success of the work.

The foregoing paper by Mr. Hayward was read by the secretary of the association.

After the reading of these papers, they were opened for discussion.

Mr. Smith stated that he had taken a greater interest in these

papers than in any series of papers for a long time. He thought that they covered a field that had not been satisfactorily covered before. It happened that when the lime, sulphur, and salt wash was first tried in Washington, the result as recorded by Mr. Marlatt and others was that it afforded but little protection. One or two others tried the same material and the results were equally poor. In a second bulletin from the U. S. Department of Agriculture, the chemical reactions in the wash were set forth and it was shown almost conclusively that it could not reasonably be expected to be of much value in in the moist East. A year or two ago one or two Jerseymen tried the wash on rather badly infested peach orchards, and the results seemed to be very good. During the past winter a number of other New Jersey fruit growers had successfully tried the wash. He called attention to a point not previously mentioned, namely, that the results of recent experiments in Illinois had been remarkably successful. He thought that the experiment there was nearly a complete success, 99 per cent of the scale having been killed at the time when Dr. Forbes's bulletin had been sent to the press. Dr. Forbes examined the experiment trees before the wash was applied, and discovered that when the winter had set in fully 50 per cent of the scale was dead. This fact was to be considered in estimating the amount of good done by washes. He had seen trees where no treatment had been made where 75 per cent of the scale was dead in the early spring. Any sort of wash put on during the winter, if no previous count had been made, would be credited with killing 75 to 80 per cent of the scale, so that there will be an element of error in the statement of results unless previous examination has been made. This is a point to which Dr. Forbes gave proper attention. He was the first one, who in his records of results, took pains to take this into consideration and published the count. Mr. Smith stated that there are a number of localities in New Jersey where the lime, sulphur, and salt wash has been used on peach, pear, and apple. Very few plums had been treated and more peach than any other fruit. One of these places is in the vicinity of Mount Holly; a second is nearer to Camden; the third is in the vicinity of Heightstown. They were all in one general section of the State, and something like 70,000 or 80,000 trees were treated on a commercial scale. The formula used was almost universally 50–50–50 to 150 gallons of water. The proportion of the sulphur to the water was nearly the same in all of the mixtures. The preparation was very thorough, some steaming and some boiling direct. He had visited almost every one of the sprayed orchards, and the last visit had been only two or three days ago. The majority of the trees were large. The work was done with barrel sprayers or with power sprayers on carts. Where the work was done on small trees that were not badly infested the results were very good. A great many trees seemed to

have few or no living scale on them. In one orchard, although the breeding season was already well advanced, there was only a single tree upon which any larvæ were found, but there were quite a number of trees where living females occurred. The adjoining orchards showed that the scale was in full progress of breeding. Wherever very badly infested orchards were found it was observed that the wash had been least effective; that is, it was not successful in killing any large percentage of the scales. A tree incrusted with scales, still coated with the spray, would, on examination, be found to contain great numbers of the living insects underneath. So where the material was most needed it was least effective. On adjacent trees on which the scales were scattering the effect of the wash was very good. The wash does not penetrate nearly as well as the oil or soap mixture, and it does not spread at all. Where it hits it sticks and seems effective, but it does not have much penetrating power. It is, furthermore, difficult to get it on the smaller twigs. This is an important point with apple trees, and unless the twig is hit the insects will not be killed. Farmers generally agree that it takes 3 gallons of the lime-sulphur-salt wash to do the work of 1 gallon of oil mixture. In New Jersey a gallon of the wash was stated to cost for material about 1½ cents. This did not include the cost of mixing and the incidental cost of boiling and time of the laborer. In practice a sufficient amount of the wash to go as far as 1 gallon of oil would cost 4½ cents. One orchardist used both, and prefers the oil because of its convenience. The farmers in New Jersey used the undiluted oil more than the emulsion. Some had tried to make a soap emulsion, but had lost all interest in the mixture. He thought there was no doubt that, particularly in peach orchards, the lime-sulphur-salt wash could be satisfactorily used. The oil was hard on peach trees, unless sprayed on with a very fine nozzle, and very carefully.

Mr. Marlatt said that he desired to join Dr. Smith in his hearty appreciation of the value of the papers presented. The experiments and work reported were of great interest on account of their considerable extent. He believed that the results of the work reported by Professor Scott and others in the South indicate that the question of how to practically control the San Jose scale has been solved. He congratulated the authors of the papers very heartily on the results obtained by them. He referred, in brief, to his personal experience with the use of oil on trees, including the orange in California.

In reference to the early experiments of the Department in the East with the lime, sulphur, and salt wash, he stated that the work was conducted by Mr. Coquillett and himself, and was carried out in the most practical way, Mr. Coquillett having recently come from California, and being thoroughly familiar with methods there employed. A careful record of weather conditions was kept subsequent to the treat-

ment. The percentage of scales killed was noted from time to time throughout the winter and the following spring, and in the case of no tree, even where the wash had been used at considerably greater strength than recommended in California, were results of any very great value seen. A full record of these experiments is given in Bulletin No. 3 (new series) of the Division of Entomology. It was noted at the time of these tests that a considerable percentage of the San Jose scale died during the winter where no treatment had been given, usually as much as 40 or 50 per cent perishing. Therefore, the treatment was considered to be of no value unless a notably greater percentage of scales were killed than would have succumbed normally. Both the California wash and the Oregon wash were tested at normal and double strengths. With the knowledge that the applications, as reported above, were more carefully made than would be ordinarily the case with farmers and fruit growers, the results were so poor that this wash was not recommended for use in the East. The reports of the success following its use in California, in view of these results, were not easily understood, and at first it was thought they might be founded on error, but the speaker had subsequently the opportunity to visit California and personally inspect results on the Pacific slope, and he found that there was no possibility of questioning the efficiency of the wash in that region. The explanation was evidently in the differences in climate between the Atlantic and Pacific coasts. In the former, the wash being applied in winter, remained on the trees unaffected by rains or moist weather, often for several months, the wash being applied after the rainy season, in late winter. In the East, on the other hand, the wash is usually subjected to washing rains within a few days after application, and it was believed that this explained the difference in results. Later on he had again taken up the investigation of the lime, sulphur, and salt wash in cooperation with the Bureau of Chemistry of the Department of Agriculture. The results of these experiments are given in Bulletin No. 31 (new series) of the Division of Entomology. The wash had been prepared with the use of a steam plant and after the most approved California methods, and was applied almost boiling hot to scale-infested trees. In this instance it killed every scale on the trees, the application being thoroughly effective. The reason for this seemed to be that the weather conditions following the experiment were very favorable. The heat of the wash does not explain the death of the scales because, however hot may be the liquid when broken up into a thin spray, it is cool a few inches distant from the nozzle. Mr. Marlatt further stated that he still believed that, as a rule, the same difference would be experienced between the East and West on account of the greater rainfall of the former section, and that the wash was on this footing, namely, that if weather conditions are

favorable it will be efficient; otherwise measurably useless. The cost of the application is very slight, especially if it is prepared in hogsheads with steam. He said that the surprising results reached by Dr. Forbes were difficult of explanation, especially as rains or artificial washing of sprayed plants did not seem to affect the efficiency in the case of his tests. He believed that the result of Dr. Forbes's work made it necessary for experiment station entomologists everywhere to give the matter again a thorough test in the East, and he proposed that the Division of Entomology in Washington undertake experiments next winter with the wash. The chemical analyses which had been made by the Bureau of Chemistry indicated that while the wash would remain in evidence as a white coating on the trees for a long time in spite of heavy rains, most of the beneficial elements would soon be leached out. As to the formula for the wash, he stated that it varied with almost every person who experimented with it. The chemical reaction between the sulphur and lime was well known, and if too much lime was used, as was ordinarily the case, it simply remained free lime in the mixture and added to the coating on the trees. The general reactions with the lime, sulphur, and salt were noted in the chemist's report in the publication cited above.

Referring to the records of percentage of scales killed, he said that in making these estimates it was necessary to take into account the transformations of the scale insects, and that the great majority of the San Jose scales on a tree in late winter would be the male scales. On trees in the orchard in the Department of Agriculture, perhaps 97 per cent of the living scales on the trees in April of this year were of the male sex. These hatch out very early in the spring, and when they are gone at once give the appearance of death to a very large percentage of the scales on the trees. He stated also that, where female scales from any cause have not been fertilized by males, their period of life is very greatly increased, so that it is sometimes possible to find overwintered female scales on trees in midsummer. An examination he had made of some of these had indicated that they had not been fertilized and were not developing eggs, and they ultimately perished without having reproduced. It thus might happen that all the male scales would be killed, and the female scales would remain unfertilized, though alive, and would perish before a succeeding brood of males would be produced.

In California the difficulty of spraying large trees was largely reduced by having them pruned back vigorously, and it was generally believed that the benefit in the ease of gathering the fruit and the superior quality of the fruit coming from this vigorous pruning offset the cost and trouble of spraying, so that the San Jose scale instead of causing a loss had really worked advantageously to the fruit grower. This applied especially to the peach and prune.

Mr. Marlatt added that Dr. Forbes's experiments had had special relation to the subsequent action of washing rains, and that they seemed to show that such rains had no effect on the benefit coming from the wash. Furthermore, Dr. Forbes had actually thoroughly washed with water trees which had been treated, and again the action of the insecticide had not been decreased. It was on this account that Professor Forbes's experiments were of so great importance and opened the whole subject for renewed investigation, indicating, as they seemed to do, that the wash could be used in regions where rains are frequent as well as in dry climates like those of the Pacific coast.

Mr. Smith suggested that perhaps a large number of small trees had been used in the experiment.

Mr. Felt in this connection called the attention of the association to the influence of rains on the wash in New York State and considered it to be apparently what would be expected. He had examined some treated limbs and found the live female scales quite abundant. He was informed that the application had been followed by quite a little rain, and in his own experiments he was in hopes that some would fall, and the rain came immediately after, thus furnishing him exactly what he desired. The entire experimental orchard was sprayed, and it seemed very doubtful if the work could be completed before the rain came, but the work was finally finished. The rain continued for about three days, so that he considered it a very severe test. The treated trees were looked over at different intervals until about ten days ago, and of the trees treated with the wash some at least contained living female scales, although most of them were not very badly infested. The most of the living insects were, as Dr. Smith had stated, under masses of scales. The wash did not penetrate into the masses, and it was his experience that where the bark was rough the insects were not seriously affected. He thought that when the wash was applied the trees should be dry.

Mr. Smith, in reply to a question, said that one of the farmers whom he had advised to use the kerosene emulsion had used 5 pounds of soap instead of one-half pound, as ordinarily recommended. The resulting mixture was very satisfactory, but it was a fatal one. The emulsion was diluted 10 times and applied to the trees just as the leaves were dropping, and the results were very disastrous.

Mr. Scott stated that in his paper he had not included his experiments with summer washes. He explained in regard to crude oil in soap emulsions that as low as 10 per cent of oil very badly damaged trees in foliage, whereas the 10 per cent in mechanical mixture did very little damage; he had found wherever the soap was used in crude oil or kerosene the results were more disastrous than in case of the mechanical mixture. Experiments had been made last winter where soap had been used in connection with the oils to determine whether

or not an excess of soap would have any beneficial effects in the kerosene and petroleum emulsions. The soap was used according to the regular formula and from that up to as high as 2 pounds of soap to the gallon of water, so that there was a large excess of soap. The results were not any better than those where the usual amount had been used. In fact, any amount of soap in excess of that necessary to make a proper emulsion he had found valueless. On the other hand, in the summer tests the soap in the emulsions was more injurious than the oils. He stated that he had found quite 40 per cent of scale dying during winter without any treatment, and he took this fact into consideration in making up the results. Frequent communications had been received from orchardists saying that the cold weather had killed the scale. Mr. Scott considered that careful estimates should be made of the scales that die without treatment in determining the percentage killed by the application of washes.

Mr. Quaintance asked if anyone had had any experience with the lime, salt, and sulphur wash in the fall, and how early it had been used. In Maryland the fall weather is usually more favorable for spraying work than the spring.

Mr. Sanderson remarked that while he had done no work with the wash himself, several orchardists of Delaware had used it, made up according to the standard formula. He had examined a badly infested orchard about ten days ago that had been thoroughly treated with the wash, and the trees at that time were still quite thoroughly coated. A careful examination of infested twigs showed that from 50 to 75 per cent of the adult females were alive. He had had slight experience in the use of crude oil on trees in foliage. Fifteen or 20 plum trees had been sprayed thoroughly, covering the leaves, but no damage had resulted, and the scales had been very largely killed.

Mr. Quaintance desired to know of Mr. Sanderson what the weather conditions were in connection with the use of the lime, salt, and sulphur wash in Delaware, to which Mr. Sanderson replied that he had no record of this. It was his experience that the scale was more readily killed in the Southern sections than in Northern sections. He had tried kerosene emulsion of the ordinary strength, diluted 10 times, and had noted very little change in results from its use.

Mr. Marlatt remarked, in reference to Mr. Scott's experience with emulsion, that the emulsion is often more dangerous to trees than pure oil—that is, if it is put on in a very strong mixture—for the reason that a thick emulsion wash adheres to the bark, and much more oil is held on a given area with the emulsion than would be in a thin pure-oil spray.

Mr. Smith stated that in the soap emulsion the oil is held longer in contact with the trees. The soap holds the oil, prevents its evaporation, and it is thus held longer in position than when put on pure.

He had found that pure oil could be used with greater safety than the soap emulsion.

Mr. Scott called attention to what had been said in regard to the scale being more readily killed in the South than in Northern latitudes and thought this must be correct, because Professor Lowe had recorded in his bulletin that he used a strength of 40 per cent crude oil, the highest ever used, but it was effective against the scale, and that 25 per cent was absolutely worthless.

Mr. Felt replied that in the vicinity of Albany Mr. Lowe's results did not hold good, and that 25 per cent would kill the scales if they were hit.

Mr. Scott stated that 25 per cent crude oil in Georgia would practically kill every scale with which it came in contact. It had been thoroughly demonstrated with two or three years' experience that 20 per cent is all that is necessary. Even 15 per cent crude oil gave good results against the scale and he did not consider it safe to use more than 25 per cent. He was glad that Mr. Marlatt had said what he did concerning the extensiveness of his experiments, as he rather feared that he might be criticised for using such a large number of trees. The Department furnished the oil and the owner furnished the labor, trees, and risk. He stated that there was one orchard in Georgia of 150,000 trees that had been sprayed with the crude oil last winter and another of 200,000, and that, unless one were pretty sure of results, it was too risky to make recommendations. Mr. Scott further stated, in response to an inquiry from Mr. Marlatt, that the crude oil in mechanical mixture was his preference of the different lines of treatment, provided that pumps could be had that would accurately discharge the proper amount of oil. Otherwise the soap emulsion is preferable.

Mr. Smith inquired if the pumps used were of the new model, to which Mr. Scott replied that they were of the latest model, that they had been used one day with the oil and water kept separate, but that it became necessary to discard these connections and change to the old style of pump. His reason for preferring the emulsion was because it could be depended upon almost absolutely, while with the mechanical mixture the pumps gave varying results. One lead of the hose might be discharging a greater percentage of oil than the other.

Mr. Scott further stated that he had used the pure crude petroleum in an experimental way the winter before. Twelve trees had been sprayed, of which number 6 were killed. He considered pure crude petroleum quite unsafe, but thought that it could be used as high as 50 per cent if applied very carefully and very lightly.

Mr. Burgess stated that from the previous discussion it appeared that it must be much more difficult to kill the scale North than farther South. In northern Ohio it was a very difficult matter to kill the scale with-

out injuring the trees. He made some tests with the kero-water pump which were not very satisfactory—that is, the pump would not throw a given percentage constantly—and in the experiments made recently a motor-spray pump had been used. This pump was used largely in the northern section of Ohio and very few trees were injured, but the scale was not held in check. This year the trees were sprayed more thoroughly. Some were over sprayed, and, as a result, at the present time, he estimated that there were probably 10,000 dead trees in that section. This is the principal fruit-growing district, and such a loss means considerable to the growers. The men who applied the spray in this section were growers who have had a great deal of experience in spraying, and certainly would be as careful as hired men. Mr. Burgess related one instance where peach trees were seriously injured by using 25 per cent mechanical mixture of crude petroleum, and called attention to a recent New York bulletin, in which it was stated, from results there indicated, that peach trees sprayed late in the spring were less liable to injury than if sprayed earlier in the season. His experience in northern Ohio was almost opposite. The trees sprayed late in the spring had been injured more than those sprayed earlier, as in January or somewhat later. The fact that so many trees had been killed and injured this year made the scale problem a serious one. The growers were enthusiastic in using the crude petroleum and thought they had found a substance which could be used safely to kill the scale. It seems now that much more care will have to be used in its application, or a safer remedy devised. A good many growers last year thought they had not sprayed sufficiently and this year attempted to spray the trees more thoroughly. On peach trees, a very careful application of crude oil must be made. Attention was called to another point in this connection—that the effect of spraying was different in different years. Some growers had sprayed thoroughly last year and no injury had resulted to their trees. The same trees had been sprayed this year with considerable injury. The results did not seem to show, one year with another, what results might be expected after spraying.

Mr. Quaintance remarked that according to his experience in Maryland there was considerable variation in the effect of both kerosene and crude petroleum in different parts of the State. In western Maryland the kerosene treatment, on the whole, had been found quite satisfactory, and 20 per cent kerosene in mechanical mixture was very largely used. On the Eastern Shore, however, the use of kerosene or crude petroleum, even under the most favorable weather conditions, had been reported in numerous cases as giving fatal results to the trees. On the whole, for this territory he was inclined to recommend the use of whale-oil soap. He stated that he had met with much difficulty in the use of the kero-water pump, from the fact that the percentage of

oil varied with nearly every pump, and even the same pump at different times. Many of the orchards in the State were managed by tenants. Under such conditions it was difficult to get the intelligent cooperation necessary to secure proper results from the use of kerosene or crude petroleum.

Mr. Smith suggested that we have to do with a problem for a plant physiologist. The records given were so contradictory that it seemed to him to be due somewhat to the condition of the plant. He suggested that the matter be investigated from this point of view and that it be referred to some plant physiologist. He considered that the experiments reported proved two or three points fairly well—that the oil would kill the insect under the scale if it comes in contact with it, and that a quantity of oil sufficient to touch the insect is all that is necessary. The question of its effect on the tree is an important one. It is not fair to take the results from one part of the country and make them the basis for recommendations for another part. The results which he had obtained in New Jersey had been duplicated time and again in his State. He had never yet succeeded in killing a peach tree with crude petroleum, but had crippled some. He knew of other persons who had killed trees. He did not understand this difference, nor why the scale is more hardy in the North than in the South.

Mr. Holland stated that crude petroleum, as generally supplied, was a most puzzling mixture. He had at the university something like 150 samples of oil ranging from white to some of high specific gravity, and thought that a chemical analysis would probably eliminate some of the trouble. He stated that he considered Professor Phillips probably best qualified to make an analysis of crude oil, and thought the work one of the most complicated problems in chemistry. He thought that if the fruit growers could get the run of certain wells the difficulty might be largely obviated.

Mr. Felt remarked that he had gotten very good results from wells in certain sections, but he was very much puzzled how such contradictory results could have been secured from New York State. The results published by Professor Lowe were not at all like those which he had obtained.

Mr. Burgess agreed that the assistance of a chemist and a plant physiologist were urgently needed.

Mr. Smith stated that the question of determining the composition of crude petroleum and of getting an oil of as uniform a grade as possible for spray purposes was recognized by him as a serious one. At his suggestion the Standard Oil Company, from which he had been securing material, had applied the term "insecticide oil" to a particular grade which they sent out under that name. Oil simply ordered as insecticide oil was of this grade, and had been very uniform, so far as he knew. This oil was and had been used in New Jersey with con-

siderable safety. He fully realized the value of the point that Dr. Holland made; he had tried to get some one to make the analysis; but no chemist seemed to want to touch the problem.

Mr. Hopkins mentioned the fact that the subject of vaseline had been under investigation by the chemists of the West Virginia station. They had taken vaseline and mixed it with kerosene, and experiments had been carried on with it. He thought Mr. Rumsey might be able to give something of interest about this work.

Mr. Rumsey replied that he considered it premature to make any statements concerning this work, as it had not been in progress very long and he had made but two inspections of the trees since the application of the oil.

Mr. Quaintance stated that in his opinion the entomologists would have to ask for help in connection with determining the cause of the variation in results from the use of oils in various parts of the eastern United States as a treatment for the San Jose scale. He considered it a very important matter and thought that the question should be straightened out and put on a scientific basis. Until this was done, the danger of injury to trees sprayed with the mineral oils would probably not be removed. He suggested that the Secretary of Agriculture be petitioned to detail an entomologist, a plant physiologist, and a chemist to make the investigation of this problem a leading line of work.

Mr. Scott stated that he had asked for prices of the Standard Oil Company on their insecticide oil, and their price, with freight added, would make it cost something like 15 or 16 cents per gallon delivered in Georgia. He had corresponded with several oil companies and found that a high-grade oil could be bought and delivered at Savannah for 8½ cents in carload lots. He had first obtained a barrel of the oil and tested it and found it averaged about 43½° Baumé. It had never run under 43° in any of the barrels that were tested. Twenty thousand gallons had been secured for last winter's work. One company proposed to put up crude-oil tanks in orchard sections of the State and supply the crude oil to the orchardist in the same manner kerosene is supplied to the merchants. He asked Dr. Smith what was the specific gravity of the oil that had been used in New Jersey.

Mr. Smith replied that this usually ran between 43° and 44°, but never ran under 43° in any of the samples which he had seen. In every section where crude oil is used, the commissioner has a hydrometer and tests the oil, so that it is thus possible to keep pretty close record of the oils in use in the State.

Mr. Sanderson suggested that the committee on resolutions take up the matter of petitioning the Secretary of Agriculture to detail investigators from the Department to help solve the problem.

Mr. Hopkins suggested that best results were likely to come from cooperative experiments.

The society then adjourned to reassemble at 10 o'clock Saturday morning.

MORNING SESSION, SATURDAY, JUNE 28, 1902.

After calling the meeting to order, the president announced that first on the programme were three papers by Mr. Marlatt:

RÉSUMÉ OF THE SEARCH FOR THE NATIVE HOME OF THE SAN JOSE SCALE IN JAPAN AND CHINA.

By C. L. Marlatt, *Washington, D. C.*

A preliminary report was read before the last meeting of this Association detailing the results of a three months'[a] investigation by the writer of the San Jose scale in central and southern Japan. The present report relates to the investigations in Japan subsequent to July 1, 1901, and the explorations in the autumn of the same year in China. This report is merely a brief summary and is preliminary to an extended account of the trip which will appear elsewhere.

In the discussion which followed the reading by Dr. Howard of the writer's preliminary paper in Denver last year, a misapprehension as to the extent and thoroughness of the investigation was evident on the part of several speakers who seemed to feel that the work had been done chiefly along the railroads, and that, therefore, the interior of Japan was not being explored; and further, that this interior region, if carefully investigated, might throw an entirely different light on the subject and perhaps would demonstrate that the interior and the more inaccessible regions of Japan were the ones from which the San Jose scale had come and in which it is native. Some of the speakers, notably Dr. Howard, felt sure that no opportunities for investigation or localities would be neglected by the writer, but several of the speakers took readily to the suggestion that the exploration of the interior, away from the railroad lines, which it was supposed had not been made, would be very desirable. The fact apparently was overlooked by all of those taking this view that railroads are a modern institution in Japan, and that instead of the older settlements following the lines of such roads in Japan, this is purely accidental. In point of fact the railroads strike through the country over the most available routes and often plunge through the heart of interior Japan, traversing the mountain wilds as well as the cultivated valleys, and are more apt to reach out-of-the-way districts than the older highways and roads. Furthermore, many of these lines have only just been completed, and in my trip southward the line which now runs from

[a] April, May, and June, 1901.

one end of the main island to the other was not finished, and a considerable portion of the trip was made by boat in consequence.

Aside, however, from the subject of working along the railroads, which in Japan has not the same significance at all that it would in a new country like America, I may call attention to the fact that very many of my trips were across islands and into the interior far from any railroad lines and even where foreigners had never before penetrated, so that I had the novel experience on several occasions of being the first foreigner seen. I feel satisfied that my explorations covered Japan sufficiently well to enable me to form a final and correct judgment on the San Jose scale problem in that country. The explored region included the five main islands of Japan, from the northernmost island, Hokkaido, to the southernmost, Kyushu, and also the islands of Awaji and Shikoku, rarely visited by foreigners, lying to the south of the main island, both of which I crossed by jinrikisha, and, in the case of the larger one, Shikoku, surmounting a high mountain range.

In my former report, which covered one-half of the time spent in Japan, or some three months, and related to the investigation of some thirty-five of the southern provinces, or districts, it was stated that there remained to be explored the northern half of the main island (Hondo) and the northern island of Hokkaido; and, furthermore, that this northern region had a special interest on account of its containing extensive apple orchards, which are developed on very much the same lines as in America.

The heat and moisture of midsummer in Japan renders life unendurable in the low countries, and, tiding over this period, some weeks were spent in the mountain regions of central Japan, dividing the time between Niko, Chuzenji, and Yumoto, places having elevations respectively of 2,000, 4,500, and 5,000 feet. From these different places side excursions were made. The whole region covered is a mountainous one and of wild forest areas, the cultivated portion being of small amount—mere garden patches in the villages. In this region also are great imperial domains or forest reserves, and in one of these is a summer palace of the imperial family. Over three weeks were spent in these mountains and a careful study was made of the district from an entomological standpoint. Insects of all kinds were very few in numbers, and scale insects were practically wanting. The fruit trees and flowering trees grown in the private yards and small gardens, comprising such plants as mulberry, cherry, plum, and peach, were often examined, but not a single scale insect was discovered. The absence of such insects is doubtless to be accounted for by the climate. In this elevated region it is cool in summer and very cold in winter, and during the summer months the rainy season normal to the period is much intensified by the mountains catching the rain-

clouds, so that downpours are of daily occurrence and the humidity is unusually great. As a result the trunks and limbs of trees are covered with lichens, moss, and fungi. In the woods, and especially on the elevated mountain plains this side of Yumoto, were found a species of wild apple, probably a Cratægus, having a fruit varying from an eighth to a quarter of an inch in diameter. No means of determining the species were available. The San Jose scale had either never been introduced into this region or had failed to get a foothold, and it certainly occurred on none of the trees planted in temple and private gardens nor on the wild plants on which it might have been expected, as, for example, this Cratægus.

Early in August the writer left this region for an extended trip through the northern provinces, the distance being covered partly by rail and partly by boat, and side excursions were made into the interior by jinrikishas. Either going or returning, stops of sufficient length to investigate the adjacent regions were made at all the principal towns, and from several of these lateral excursions were made. In the north island the exploration covered the principal town on the southern shore, Hakodate, and a trip across the center of the island from the east to the west side, with a stop of some four or five days in the capital town of Sapporo.

Over a large region in the northern end of the main island of Japan (Hondo) Japanese settlement and complete occupation has only taken place within modern times, and there are still large areas in native grass land, the rolling nature of the country in portions of this region recalling somewhat our own prairies of the Middle West. Throughout this section and in the island of Hokkaido, which is also new to Japanese settlement, the agricultural conditions and methods are totally different from those of the older settled portions of Japan. Horticulture especially is here modeled more directly after the American pattern, and in the north island American methods of farming as well as of fruit raising are closely copied. This is largely due to the work of the agricultural college at Sapporo, where for many years were American instructors and a general introduction of American methods. This institution is continued now under Japanese direction and with a Japanese faculty, but the whole region, both in its fruit raising and general farming, reminds one very strongly of America.

The chief interest in this region comes from the fact that in the northern provinces of Hondo and in the settled portions of Hokkaido fruit raising has been developed on a scale not equaled elsewhere in Japan. The fruit raised is chiefly the apple, and the products of this region supply Japan, and to a certain extent, also, the markets of eastern Asia. The apple is grown in all this region very much as it is with us, in large orchards; the varieties are our varieties, and have been imported from America, very few European varieties having been introduced.

The apple industry in Japan, as indicated in my former communication, is of recent origin, say within the last thirty years; most of the stock has been obtained from California, and, as a rule, was undoubtedly more or less infested with San Jose scale when received. Throughout this region the San Jose scale was found scatteringly in all orchards and in all gardens. In Aomori and vicinity it was doing no very great damage in any of the orchards, but in some of the small gardens, and especially in one or two neglected ones in the city of Aomori, it was as abundant on particular trees as it often is in America. At the first investigation no evidence of parasitism was seen, but from later collections two of the parasites which attack this scale insect in America were reared in great numbers from infested branches collected in Aomori. These, as determined by Dr. Howard, are *Aphelinus fuscipennis* How. and *Aspidiotiphagus citrinus* (Craw.), the latter being the more numerous.

The Asiatic ladybird (*Chilocorus similis*) was found throughout this northern region of Japan, and evidently was an efficient means in keeping the scale in check. In certain gardens in the city where the scale was very abundant the infestation was evidently of recent beginning, a tree here and there only being very scaly, and in some instances the ladybird enemy had not yet come upon the infested plants. In other places in the city the ladybird was found in numbers, and a score were collected and put in a tight wooden box with some scale-infested twigs to determine how long the beetles could be kept safely under such conditions, as a preliminary test before attempting to ship them to America.

On the return trip to Aomori some side excursions were made by rail and jinrikisha to orchard regions toward the west coast of the island in company with Mr. Hori and some of the horticultural officers of the province. Wherever we went was found a general infestation by the San Jose scale in orchards and gardens, the scale occurring normally very scatteringly, and not at all in especially injurious numbers. Everywhere also was seen the same evidence of the scale being kept in check by parasitism by the Chalcidids which attack it in America, and especially by the predatory Chilocorus.

In the northern island the points especially investigated were Hakodate and Sapporo, the latter town being the capital city and, as already indicated, the seat of the agricultural college and experiment station and the center of modern agricultural and horticultural methods. The conditions, so far as scale insects were concerned, were practically the same at both of these places, and at one or two other places where more limited investigations were made, as, for example, at Mororan and Otaru.

The island of Hokkaido is even more wild and unsettled than the northern extremity of Hondo, and in fact, during the last thirty or

forty years only has there been much effort on the part of the Japanese to settle this large island and bring it under agricultural subjection. The native Aino race, with which the Japanese have been pursuing a guerrilla warfare for the last two thousand years, has now practically disappeared, and there being no obstacle to settlement, the Japanese are swarming in. Approaching Sapporo, the country becomes more settled, and many apple and pear orchards line the railway. A very careful investigation was made, covering several days, of the region about Sapporo, the studies being assisted by the various officers of the college, notably the botanist, forester, and horticulturist, and also by Mr. Hori, who was at one time a student at this institution, and who had joined me at Aomori for my northern trip. The orchards throughout this region could be given a practically clean bill of health so far as insects are concerned. The San Jose scale had practically died out, never having apparently amounted to anything here, and the only evidences of it were a few old dead scales. Nearly all the apple trees showed slight infestation by the oyster-shell bark louse, which the Japanese seem to have imported from America along with their original invoices of nursery stock. This scale insect also seemed to be having difficulty in maintaining itself and occurred in very limited numbers, those found being, as a rule, dead—living individuals being found only in protected cracks and crevices in the bark. The cherry scale (*Diaspis pentagona*) was very rare or practically absent, very few single examples being found on cherry trees. The orchards included plum, peach, and cherry, as well as apple and pear. The scale-feeding ladybird (*Chilocorus similis*) was in evidence scatteringly everywhere feeding upon Mytilaspis, this being the only scale insect which remained to furnish it any food. The investigation covered a number of private orchards, the orchards belonging to the agricultural college, and the parks and grounds in the city.

On the return to Tokyo from northern Japan many places were stopped at which need not be specifically noted, the conditions not being essentially new. Mito, however, a city two or three hours by rail northwest of Tokyo, deserves mention. It is the site of some very wonderful old gardens or orchards of plum trees grown not for fruit, but for the bloom. The famous orchard of this place surrounds one of the old Daimyo residences, and for many years has been a pilgrimage place for the people of Tokyo and that part of Japan in the flowering season in early spring. These old orchard trees, a hundred years old or more, covered with lichens, did not present any infestation from scale insects whatever; not a sign of the San Jose scale could be found on them. In fact, I found no scale insect in this region except a very few dead *Diaspis pentagona* on cherry.

After returning to Tokyo the orchards between Tokyo and Yokohama, which had been visited early in the year and found to be infested with San Jose scale, were again inspected. A few of the trees had been subjected to some treatment during the summer, evidently with soap, and most of the scale insects had been killed either by the soapy treatment or by ladybird enemies or parasites.

Before leaving Japan opportunity was afforded to explore another interior mountain district, viz, the great mountain plateau known as the Hakone region, and a week was spent going by jinrikisha and chair and on foot over these volcanic mountains. The native settlements are largely about Hot Springs, which have become famous as Japanese and foreign health resorts. No evidence whatever of the San Jose scale was found throughout this region, and the scale insects collected were few in amount and variety. In all this region there were old cherry trees and pear trees in house yards, but no orchard plantings of any amount.

It is impossible in this summary to give the detailed facts on which the decision as to the non-origin of the San Jose scale in Japan is based. Nevertheless, perhaps enough has been said to give a fair idea of the prevalent conditions. In a general way, it may be stated that wherever the San Jose scale was found in Japan the evidence was very plain that it had been brought in recently on young nursery stock. Very often in south Japan, where the introduction of new stock is of recent beginning, the San Jose scale is still confined to the introduced stock, or has spread very slightly to the old native trees, notably the native Japanese pear. In no case was the San Jose scale found on these native trees where there was not ample opportunity for its having come to them from new stock. In north Japan the apple industry is from twenty to thirty years' standing, and is entirely new to Japan, as already indicated, the stock having practically all come from California. Furthermore, the chief sources of nursery supplies in Japan are three establishments, located one near Kobe, another near Yokohama, and the third near Tokyo. Two of these I investigated personally and found to be infested with San Jose scale. The infestation was on the nursery trees, and also on older trees left in the general disposal of stock. In nearly every case in south Japan where the San Jose scale was found it was on stock obtained from one or other of these three nurseries, and the origin of the scale was perfectly plain. In northern Japan the introduction of foreign trees twenty-five or thirty years ago has given this scale a much wider and more general range, but even here wherever you get away from young orchards and new plantings the scale disappears. That, therefore, the San Jose scale came to Japan on American stock, and is a new enemy there of fruit trees, can not be questioned.

The Japanese are extraordinarily ambitious to equal other nations in all lines of productive activity as well as in social and political life, and hence one finds in going over the Empire an astonishing number of places where limited experiments with American fruits are being carried on in private gardens and the like, and this fact accounts for the wide dissemination of the San Jose scale throughout central and southern Japan, where fruit raising, especially of the deciduous sort, is insignificant.

It was noted also that in the more remote islands where such introductions had been little if at all made, and in districts where new stock had not penetrated, there was no San Jose scale on old native trees. Furthermore, the interior mountain regions which some have thought might be the original home of the scale are entirely free from this insect, save in rare places where it occurs on recently introduced stock.

The belief also that the absence of the scale, or its being not much in evidence is due to a natural resistance of the native fruits is without foundation. The native pear trees, when the scale is brought to them by new stock, are subject to the infestation quite as much as the foreign stock. In the case of old gnarly trees of half a century or more standing the chance of great infestation is, of course, less, as it would be under the same circumstances with the old trees in America. But young native stock seems to be just as subject to attack as foreign varieties. There is an immunity, however, in the case of the Japanese peach, but this is not complete, and is to be explained by the very rough bark developed by this tree, especially in the central and southern provinces.

Anyone studying the San Jose scale in Japan at the present time without a knowledge of the horticultural history of the country and especially its recent development, as indicated above and in my former communication, might very readily and naturally be deceived by the present distribution of this scale insect throughout the islands—as one might similarly be deceived by a study of the present conditions in America—and conclude that Japan (or America) is the native home of the scale.

Not only might the present wide distribution of the San Jose scale in Japan lead to the belief that it is there a native species, but apparent confirmation of this belief would be forthcoming in the finding, very rarely, it is true, of old native pear trees attacked by this insect with no new stock near by to account for the infestation. Two such cases were noted by the writer, and may be described to illustrate this point. Near one of the buildings of the Agricultural College at Kumomoto, in the island of Kiushu, stood an isolated old native pear tree which was somewhat infested with San Jose scale. At the moment there seemed no way of accounting for this infestation, but within a distance of not many rods was found a planting of young

apple and pear trees badly infested with scale. It was learned that this stock was obtained from the infested nursery near Kobe, which has been the chief source of San Jose scale distribution in southern Japan. Undoubtedly in this case the old native tree had been infested from this new stock. Confirming this inference is the fact that in the grounds of the experiment station, a mile or two distant from the college, and where no new fruit stock had been introduced, were a number of these old native pear trees all absolutely free from this scale insect. It may be added that both the college and experiment station are of recent establishment, and the old pear trees referred to were the remains of stock growing about the old Japanese farm houses prior to the purchase of the land for the college and experimental farms. The other instance was on the island of Shikoku, just outside of the city of Takamatsu, where a single old native pear tree growing in the yard of a farm house was found infested with San Jose scale. No young orchards or new plantings immediately about these premises were observed, which, however, did not prove that there were or had been none such. But in the old Daimyo Park, attached to the city not half a mile distant, was a lot of infested peach stock from the Kobe nursery referred to above. In every other instance where the San Jose scale was found on native trees there was new stock in the immediate vicinity to account for the infestation. Of even greater significance is the fact that in the great majority of instances such old native pear trees in dooryards throughout Japan were free from the San Jose scale and yet practically always bore a few specimens, at least, of a native Parlatoria and a native Mytilaspis. If the San Jose scale were native in Japan it should also have occurred with the scale insects just named.[a]

While freeing Japan from the onus of having given the San Jose scale to the world, the investigations up to this stage left the problem unsettled as to the original home of this insect. Australia and the adjacent islands seemed to be in the same condition relative to the San Jose scale as Japan, namely, there is but little doubt that it has come into these countries on foreign stock in recent years. China remained, therefore, the only probable place of origin. In Yokohama and elsewhere I was fortunate enough to meet a number of English, American, and German residents of China who were spending the summer months in Japan, and from them I was able to get what is not given in any of

[a] Relative to the recent introduction of the San Jose scale into Japan, it is interesting to note that Mr. Albert Koebele in 1895 spent several months in Japan, and failed absolutely to find the San Jose scale anywhere, and all of us who know Mr. Koebele will understand what this means, because no better collector of insects in general, and of scale insects in particular, than Mr. Koebele has ever lived. This is simply confirmatory evidence (if such be needed) of the recent spread of this scale insect throughout Japan.

the books—an idea of the fruit-growing conditions of China and the location of the principal fruit districts.

Deciduous fruits are grown from the Shanghai region northward. The peach is practically the only fruit grown to any extent about Shanghai. The great apple district of China is the region lying back of the city of Chifu in the north. The industry here started many years ago by a missionary, Dr. Nevius, has assumed very considerable proportions and spread over quite a large province, and the output of fruit is found in the markets all over central and southern China. A brief stop only was made at Shanghai in the first instance while preparations were being made for the trip to north China, the distance between Shanghai and Tientsin necessitating a five days' ocean voyage.

At Chifu an exploration was made on horseback through the districts lying back of the city, a good many orchards being visited, and notably the original orchard planted by Dr. Nevius, and the gardens and smaller orchards immediately surrounding his residence, some little distance outside of the city. Most unfortunate for the history of the fruit development of this region and of the native fruits of this part of China is Dr. Nevius's recent death. His widow, whom I met, was unable to give me any information, except that the doctor had been very active as a horticulturist during all his long residence there (thirty years), and had been the exciting agent in the development of the fruit industry of that region. His stock had mostly been obtained from America, and American varieties of apples and pears were being grown in the province. Throughout this region I found a mild infestation with the San Jose scale, with the accompanying presence of the *Chilocorus similis*.[a]

The occurrence of the San Jose scale about Chifu was not significant, and threw no light on the subject of origin on account of the fact of importations from America of stock (doubtless much of it infested) and its dissemination over this province. The fact that the scale insect was not very troublesome in this region was, however, very significant, and this was evidently due to the general presence of the ladybird. Chalcidid parasitism was not common, and the scale was hardly abundant enough to develop much of such parasitism.

The next point examined after Chifu was Tientsin, and the region lying between this considerable city and its port town of Tonkoo, after which the trip was continued to the capital city of Pekin. Much of the region of China bordering the gulf of Pechili is perfectly level and flat, and only raised a few feet above the ocean. It is devoted to the growth of cereals, wheat, barley, and millet, and orchard plantings are practically wanting until one gets into the hill country lying

[a] *Diaspis pentagona*, previously found throughout Japan, was also widely spread in China, occurring from Pekin southward to the Malay Peninsula and into Java, exhibiting in its range a wide diversity of food plants.

to the north and west, leading up to the Great Wall of China. My personal investigations of this region were confined to the district about Pekin and between Pekin and Tonkoo. Our minister at Pekin, Mr. Conger, kindly offered to give me an escort of Chinese soldiers to explore the mountain region north of Pekin, but I was able to satisfy myself of the conditions without undertaking this trip, which at this season of the year would have been almost impossible, and, in view of the unsettled state of the country, attended with considerable risk.

The facts which I learned here of greatest interest were obtained from the examination of the markets in the city of Pekin. To explain this it should be said that Pekin is the natural center and market for all the region lying to the north and west, and the streets devoted to the sale of fruits in the Chinese city are one of the sights of Pekin. The fruit and nut products are brought into Pekin in the little two-wheeled carts, or more generally on camel-back, great caravans of heavily loaded camels and streams of carts constantly entering the city with the products of the outlying provinces. One gets, therefore, in the markets of the Chinese city the fruit products of all northern China, and can study them at ease.

The conditions under which this fruit is grown I was fortunate enough to learn from engineers, officers, and others who had explored the region in question. All of the district lying between Pekin and the Great Wall to the north and west has been very carefully explored by the military authorities, and maps which amount to local road maps of the whole country have been made. From various individuals employed in this minute survey, I learned a great deal relative to the fruit growing of the district indicated. Much fruit is grown south of the Great Wall, chiefly along the protected valleys running southward and eastward from the mountain chain which this wall dominates. These fruits are native apple, pear, and peach, and a little wild haw apple which grows all over the hills. Of these fruits I examined quantities of all except the peach (which was now out of season) in the markets of Pekin, and later at Tientsin. Throughout all this region no foreign introductions of fruits or fruit trees have ever been made, and the fruits in the market are all of the native sorts. The pears are little and hard, somewhat like the native Japanese pear in firmness, but being elongate instead of spherical. The apples are what we term crab-apples, even the largest; and the smaller ones, which are more numerously represented, are not much larger than marbles, and of a brilliant red. The haw apple grows wild over the hills in this region, and is collected and shipped by thousands of bushels to Pekin and southern ports. It is of about the size of the small crab-apple just mentioned, and also a deep red, somewhat obscured, however, by a downy pubescence. This haw apple is much esteemed by the Chinese, and our min-

ister, Mr. Conger, assured me that he was very fond of the jelly which is prepared from it. It is the most abundant fruit seen in all the markets of North China, and is even shipped as far south as Hongkong. I examined a great many bushels of these different fruits, the red crab-apples and haw apples, and throughout the market I found them all infested with a scale insect which resembled exactly the San Jose scale and was later identified as such. Perhaps one apple in a hundred would have a few of these scales about the blossom end, and about the same proportion was true of the haw apple.

In making these examinations great excitement was caused among the Chinese market people, no possible explanation occurring to them for my curious and unusual conduct in overturning their baskets of apples and pawing them over and taking out one specimen out of a hundred or two, and invariably a great crowd of Chinese, jabbering excitedly, surrounded me. Occasionally finding a man who could speak a little pigeon English, I would give the only explanation which they seemed to understand, namely, that I was picking out certain minute insects, which I showed to them and allowed them to examine through my glass, which were of exceptional value as medicine. The use of insects for medicine being common in China, this explanation at once reinstated me in the esteem of all.

The finding of the San Jose scale scattered over these fruits in the Pekin market was a very interesting discovery. The haw apple is a wild fruit growing over the hills of this section of China. The native crab is the apple which has been grown in this region from time immemorial. The occurrence of the San Jose scale on these two fruits and on the native pear also has but one explanation, namely, that in this section the scale is native. The fact of its scattering occurrence is what one would expect under the circumstances, namely, in a region where a scale has always occurred it has reached the balance with its natural enemies, so that it is rarely, if ever, injurious.

The conditions indicated in the markets of Pekin were substantiated by examinations in Pekin and in Tientsin. Pekin was an utterly destroyed city and very little of residences or gardens were left for examination. Tientsin was little injured by the war, and a good many gardens were examined. Fruit growing in this region, however, does not occur to any extent, and the gardens simply exhibited a few trees and chiefly the ornamental plants of the region, notably the Chinese flowering peach, which is grown solely for its bloom, its fruit being diminutive and not edible. This peach I found nearly everywhere scatteringly infested with the San Jose scale, and always with it the ladybird, *Chilocorus similis*. This predaceous insect seemed to sustain the same rôle throughout north China as in Japan. At Tientsin, through the courtesy of the German medical authorities, I was able to make a microscopical examination of the scale insects, and demonstrated beyond question that they are the San Jose species.

Returning later to Shanghai, after making another short stop at Chifu, I made a thorough examination of the peach-orchard district lying to the west of this city, and in these orchards I found not a trace of the San Jose scale. Later I examined several of the small Chinese nurseries and gardens in and about the city, and in one of these nurseries I found on some young stock the San Jose scale. It was dying out, however, and evidently the climate of Shanghai and southward in China is not one which the San Jose scale can successfully endure. The difficulty is probably due to the excessive heat and the accompanying great moisture of the rainy season of summer, which probably develops a fungous disease and exterminates the scale. The plants of this whole region are notably free from scale attack, with the single exception of the holly, which is usually considerably infested with wax scale, *Ceroplastes* sp.

Later I made a trip into the interior of China from Shanghai by houseboat, examining orchards and house plantings en route, but without finding a trace of the San Jose scale anywhere, nor any other scale insect, except in one or two instances. The greedy scale (*Aspidiotus cydoniæ?*) was found once on a few twigs only, and an occasional very slight infestation, represented by a few specimens only, of the *Diaspis pentagona*, all bearing out the idea that the climate of this region is not suitable to the ready multiplication of scale insects.

Below Shanghai one gets into a subtropical climate, and the orange, pomelo, and mandarin take the place of deciduous fruits. My entomological explorations were continued very briefly at Hong Kong, in south China, where in the markets I found the haw apple and crab apple from north China, and with considerable thoroughness in the British Straits settlements about Singapore and in Java, and later in Ceylon and the various points touched en route home. The San Jose scale story, however, ends with Shanghai.

The question immediately suggests itself, why was not Japan early infested with this insect from her near neighbor, China? This would be expected as the natural and early result of the contiguity of the two countries. The explanation is forthcoming when the history of the political relationship of these two countries is investigated. China and Japan have been sworn enemies and jealous rivals in all past time, and commercial and friendly intercourse between the two countries has been practically wanting. Japan, it is true, has taken her alphabet and much of her learning and civilization from China, and 600 years after Christ her Buddhist religion also, which now divides honors with the native shinto religion of the country. All this has come to Japan, not from China direct but through Korea. Japan conquered Korea very early in the present era, 200 A. D., in the reign of the famous Empress Jingo, and has ever since claimed and exercised a greater or less sovereignty over this country. Reference to the

map of Asia indicates furthermore that Japan is not directly opposed to China, but to Korea and what is now Russian territory and Manchuria, and if she obtained any deciduous fruits from the continent, they came from Korea and not China. The orange and subtropical fruits were brought from the south, and in modern times whatever trade has been with China through the agency of the Portuguese and Dutch has been with the southern ports, where the San Jose scale does not exist.

Practically the only relations which China has had with Japan anterior to the opening of the latter country to the commerce of the world was the sending early in this era of certain embassies demanding tribute from Japan. The reply to these embassies was to send back the heads of the ambassadors. Following this, two efforts were made during the reign of Kublei Kahn to conquer Japan. In both instances the enormous fleets of the great Mongolian conqueror were utterly destroyed by a hurricane, and every Mongolian or Chinaman that succeeded in escaping the waves and getting ashore was promptly decapitated by the waiting Japanese. The Japanese made no attempt to conquer China until their notably successful war of 1895.

It will be seen, therefore, that there has been very little chance of commercial intercourse between these two countries, and this explanation seems to be the chief one in accounting for the failure of an insect common in the region north of Pekin to reach Japan. Furthermore, it may be said that the commercial intercourse which has sprung up so actively in later years with Japan has been, so far as fruits and trees are concerned, solely with the region from Shanghai southward, and the introduction of fruits and the like has not been from China to Japan but the other way, and it is quite possible that the San Jose scale which I found at Shanghai was imported from Japan on stock sent over to the local Chinese nurserymen.

As a matter of interest it may be here noted that the native home of the San Jose scale in China is a fairly well shut-off region, and this accounts probably for the failure of this insect to become a world pest ages ago. The district in question is the hill region leading up to the mountains and Great Wall and comprises the northern and northwestern frontier of China proper. Beyond the Great Wall on the north and west lies Mongolia, consisting chiefly of the vast desert of Gobi; to the northeast and separating the region from Manchuria and Korea is the little Gobi Desert; to the south and east lie the great alluvial plain, the product of centuries of mud carried down by the Yellow River—a region where cereals only are grown.

These are all effective barriers, and especially so when considered in connection with the political conditions of the past. The alluvial plain on the southeast is not now and seems never to have been devoted in the least to fruit, and farther south the climate becomes unfavorable, as already noted.

We have, therefore, as the original home of this insect a naturally shut-off area from which it could not easily escape under the conditions prevailing up to our own times.

The means by which the San Jose scale came from China to America is a matter of interest and offers room for conjecture. The San Jose scale apparently reached California on trees imported by the late James Lick. It was known that this gentleman was a great lover and energetic importer of trees from foreign countries, and my own belief is that he imported from China, possibly through this same Dr. Nevius or some other, the flowering Chinese peach, and brought with it the San Jose scale to his premises. At any rate, I believe that this insect, which should now be known as the *Chinese scale*, came to this country on some ornamental stock from North China.

PRELIMINARY REPORT ON THE IMPORTATION AND PRESENT STATUS OF THE ASIATIC LADYBIRD.

(*Chilocorus similis.*)

By C. L. Marlatt, *Washington, D. C.*

In this place a brief account only will be given of the importation of this ladybird and of the present outlook of the experiment. A detailed account of this insect, giving full life-history studies and other points of interest, will be published elsewhere. It has already been indicated in the foregoing account of the search for the San Jose scale in China and Japan that this ladybird was everywhere present in both of these countries, feeding on the San Jose scale and *Diaspis pentagona*. The latter scale insect, as was pointed out, is common to all eastern Asia, including Japan, and the East Indies, and undoubtedly, from its wide distribution and local occurrence in most out-of-the-way districts, is a native of this region and has been spread about in times so remotely past as to be beyond determination. It is probably a tropical species which has worked northward until practically the whole region as far as Pekin, in China, and the north island of Japan has been covered. Whether the ladybird, *Chilocorus similis*, was in ancient times the natural enemy of the Diaspis can not be determined, although the more wide occurrence of the Diaspis might lead to this idea. This ladybird, however, like other members of its genus, is a general feeder, and will attack other scale insects, even the young of the unarmored scale insects as well as the Diaspine scales. Wherever it was found with the San Jose scale, however, it was very evident that it fed on this scale insect with perhaps even greater readiness than it did on the Diaspis, and in our experimental breeding cages in Washington it has bred faster and done better on the San Jose scale than on the Diaspis.

After finding this ladybird so generally present with the San Jose scale, and apparently so efficient in keeping the latter within reason-

able limits, the desirability of introducing it into America was very evident. While in Japan I was unable to determine whether Mr. Albert Koebele, in any of his numerous importations, had sent this ladybird into California, but it seemed more than probable that he had done so, and I wrote to Mr. Koebele, at Honolulu, H. I., and some months later after I had made my shipments I received information from him that he had sent a lot of material to Mr. Alexander Craw, and that the latter had carried it through the winter successfully, but further than that he knew nothing of it. It is possible that the material introduced by Mr. Koebele has established itself in California. Since my return from the Orient, and within a few days, I have learned from Prof. J. B. Smith that he also had had some specimens of this insect sent to him from Japan by one of his Japanese correspondents. These were liberated at once in the fall in an infested apple orchard in New Jersey and nothing has been seen of the insects since, Professor Smith believing that they perished. Judging from the small percentage of survivors of those which I imported, I think it very likely that Professor Smith's specimens all died during the winter.

As a preliminary experiment to determine the possibility of shipping them across the ocean I collected, about the middle of August, a lot of the beetles in North Japan on trees infested with San Jose scale and carried them about with me in my travels for over two weeks in a tight wooden box with some infested twigs as food. These beetles, kept under conditions which certainly were not very favorable, being among other goods in my baggage, and subject to much shaking, came through the ordeal in perfect condition, and I shipped them to Washington with a lot of others collected, with the assistance of Mr. Hori, about Tokyo.

Three packages were sent about the middle of September, and of this first sending some twenty odd specimens reached Washington in fairly good condition, active, and apparently uninjured, and Mr. Kotinsky, who was given the beetles in charge, from his records is able to say definitely that it was individuals from this first sending that successfully overwintered. A sending two weeks later was made from specimens collected about Yokohama and Tokyo, together with a few taken in the interior hill region. A third sending was made from material collected about Tientsin and later at Shanghai, the specimens at Shanghai being found feeding on the young of a wax scale on holly, the beetles occurring there in considerable numbers. The distance from Shanghai to America by boat is a week or ten days longer than from Japan, and six or seven weeks are required for their arrival at their destination in Washington. The sendings from China were received in rather poor condition, and Mr. Kotinsky assures me that all of the specimens of this lot which were alive when received died during the winter.

On leaving Japan I had made arrangements with the entomological

authorities of the Central Experiment Station at Nishigahara, near Tokyo, to make additional sendings, and a little package was received early in the spring of 1902 from the chief entomologist of the station, Mr. Onuki. This material, however, came in a very bad condition, and the few surviving beetles soon perished.

The material shipped in the first instance by me was in three wooden boxes, two sent through the mails and one personally carried across the Pacific by Miss Laura Bell, whom I had met in Japan, and who kindly promised to mail it to Washington as soon as she landed in Vancouver. All of this material and the subsequent sendings also, so far as I could control them, were mailed to take the Canadian Pacific steamers to get the advantage of the northern and much cooler as well as shorter passage. I am unable to determine, the record having been lost, whether the specimens which overwintered were those personally carried by Miss Bell or those sent through the mail. At any rate, but two individuals survived. It is possible that with proper precautions a much larger number could have been successfully hibernated, but they were kept indoors, and for part of the time in heated rooms, and the survival of two was, under the circumstances, a rather fortunate outcome. Furthermore, many of the beetles were possibly spent ones when collected.

In April, after the eggs were recognized, the beetles and eggs were transferred to and kept in a jar in the greenhouse on fresh scale-infested twigs until larvæ were produced in considerable numbers. Undoubtedly a good many of the eggs first laid were overlooked because of the peculiar habits of oviposition of the beetle, which seem not to have been previously noted. Later on the eggs were discovered and some 50 larvæ were reared in this manner indoors. Afterwards the beetles and the larvæ were from time to time transferred to a big out-of-door cage, 6 feet square and 9 feet high, inclosing a plum tree thickly infested with *Diaspis pentagona*. Ultimately all of the indoor-bred larvæ were transferred to this tree, about 100 altogether, and, judging from the rate of oviposition, at least 100 additional eggs were deposited on the tree by the parent beetle before the latter perished. So far as we could determine, but one of the two surviving beetles was a female, and 200 eggs or more were obtained from her after a good many had been lost or thrown out with the wood on which she had been feeding before the eggs were recognized.

The life period of these beetles is evidently considerable. The two imported ones which survived the winter were active and vigorous until about the end of May, when they perished, the supposed male preceding the female by about a week or ten days. They, in other words, had been kept in captivity for nearly a year, having been collected early in September. This would indicate a life period of at least twelve months, because they were necessarily more than a month

old from the egg when captured, and their lives were probably shortened by the unusual conditions and experiences to which they were subjected. This long life is of very considerable importance in considering the value of these insects as exterminators of the San Jose scale. Their fecundity is also considerable, as indicated by the actual securing of some 200 eggs from an imported specimen and under unfavorable conditions, not counting the loss of a good many eggs. It is not improbable, therefore, that a single female may be the parent of at least 500 young, and the period of usefulness of an individual may extend over twelve months.

The egg is normally concealed under an adult female scale. In other words, the beetle selects a suitable scale, drags out the female scale insect, and either eats it while ovipositing or drops it, turns about and thrusts the ovipositor under the slightly lifted edge of the scale, and in two or more minutes deposits a single egg. This habit of oviposition seems to be peculiar to this species. It was found later on, when the beetles became more numerous, and especially during the period when the old female San Jose scales were not so abundant, and the trees were covered with young scale insects, that other locations would be chosen by the beetle for oviposition, namely, under the loose edge of bark or like situation, or more rarely eggs would be deposited exposed on the bark.

Later in the summer other large cages were built over some pear trees infested with San Jose scale. In all five such cages were built, each of the four later ones including two pear trees about ten years of age but cut back to small size. In these cages the beetles throve wonderfully well. One cage in which two individuals, a male and a female, were placed in May, was swarming with beetles by the middle of July, and more than 100 beetles were taken from it for distribution elsewhere without greatly lessening the stock.

The multiplication of the beetles at this stage was fairly satisfactory, not so much so, however, as it should have been if the experiment had not been interfered with by the presence of certain predaceous insects to be considered later, notably the wheel bug, two species of praying Mantis, lace-winged fly larva, and the larva of *Adalia bipunctata*, it being almost impossible to free these rather large cages from all of these insects. In spite of all the drawbacks, however, the beetles have multiplied to exceed 500 specimens, perhaps 1,000, by the 1st of July from the single overwintered pair, but one of which was presumably a female.

We are making arrangements to ship these beetles to the entomologists and State experiment stations this summer and fall, and we hope to establish this ladybird in the eastern United States. It feeds voraciously on the San Jose scale and on the Diaspis. The larvæ are eating all the time, and the rate of multiplication is such that five annual

broods may be counted on, the third brood in our own breeding cages being under way in the latter part of June. Whether this ladybird enemy of the San Jose scale will really amount to anything as an efficient means of controlling this pest remains to be demonstrated. The San Jose scale is its normal and natural food. It multiplies rapidly, and a larval Chilocorus destroys an enormous number of young scale larvæ in a day, by actual count 1,500 per day or about one a minute, but while actively feeding at the rate of 5 or 6 a minute. The main question to be decided is whether this insect can be successfully established in this country, and if so, whether our native predaceous insects will allow it to yield the full benefit which it should give in keeping down the San Jose scale. We make no extravagant claims, but believe that the experiment is well worth trying, whatever may be the outcome.[a]

It has been suggested that this ladybird is the same as our native species, *Chilocorus bivulnerus*, and, in fact, the superficial resemblance of the adults of the two species is so close that the greatest difficulty will be found in distinguishing them. The larvæ of the two species, however, are distinctly different in general appearance. The Asiatic has the skin of a reddish or flesh tint, the spines being black but less prominent than in our native species. The skin of our native species is a dull gray, and the general appearance of the larva, therefore, is decidedly black or dark, whereas the imported species, when full fed, is reddish. Furthermore, there are structural differences in the spines and hairs which will enable one readily to separate them irrespective of the difference in appearance, which is very striking. The beetles also can be separated, as I am assured by Mr. E. A. Schwarz, although careful anatomical and structural studies have not been made at this writing. The imported species is notably smaller on the average than our native species, and rather more brilliantly colored, and differs a little perhaps in the general shape or convexity of the wings and thorax. Furthermore, it feeds on the San José scale and the Diaspis naturally and normally. Our species, while it is often found in scale-infested orchards in the East, has never done very much good in the orchards, and does not feed and multiply on the scale in the way that it ought. For example, in the grounds of the Department of Agriculture this year we have a little orchard of pear trees thickly infested with the San José scale—the orchard in which we are establishing this foreign ladybird—and yet in all the time during the spring and early

[a] It may be added to the above that during the balance of the summer this beetle did very well in the little Department grove. About a thousand beetles were distributed to various entomologists, from some of whom reports of considerable success have already been received. In Washington breeding seemed to stop toward the end of September, but we now have more than 2,000 beetles which will be overwintered Next year we should have them in quantities for general distribution.

summer of this year that this orchard has been under constant and careful observation but one or two beetles of our native species have appeared, and but two of its larvæ have been seen on the trees. Yet within a stone's throw of this orchard is a tree on the grounds of the Department infested with *A. aneylus*, and on this tree, infested with a native scale insect, the *Chilocorus bivulnerus* has established itself in considerable numbers, probably several hundred larvæ being present on the tree. The history of this ladybird in the East, and as further illustrated by the instance just mentioned, seems to indicate that it prefers our native scale insects and has not yet fully accustomed itself to the San José scale nor to the recently introduced *Diaspis pentagona*. It may take hold of these new scale insects in the course of years, but it certainly does not do so at present in a manner to be of any great assistance in keeping them in check."[a] In Florida and California especially on Citrus trees it is very abundant, as a rule, and an efficient enemy of scale insects. The imported species feeds normally and voraciously on the San José scale and Diaspis, and, if it survives our climate and can be established, we may hope that it will accomplish for us some, at least, of the good results which it was seen to achieve generally for China and Japan.

In the matter of climate, it may be said that the region in which it occured in China and Japan will duplicate nearly enough the eastern United States or California. We have about the same summer and winter temperature and similar general conditions of rainfall and other climatic features, so that from this point of view there seems to be no reason why the imported ladybird should not do well.

That this ladybird or any other parasitic or predaceous insect will ever completely subdue the San José scale in the United States is very problematical, and there is very little doubt but that in future, as in the past, to free an orchard from this scale pest it will be necessary to take the direct and active means now being employed, such as the use of oil, or the lime, sulphur, and salt wash, or other remedies which experience shall demonstrate to be effective. What parasites or predaceous enemies may do is to keep this scale in check so that it will not be so generally abundant and destructive, and especially to keep it down in the thousands of small orchards and gardens where direct spraying operations would not often be undertaken by the owners.

In particular districts it may even put a complete check on the San Jose scale for one or several years. That this is possible is indicated

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[a] Toward the end of July some 26 specimens of the native *Chilocorus bivulnerus* were caged over a San Jose scale-infested pear tree to make comparative studies of the life history and habits of the species. Unfortunately, however, all of these beetles perished, without our securing either eggs or larvæ. This rather astonishing and unexpected outcome seemed to be due to a distinct disinclination on the part of these beetles to eat the San Jose scale except in the most sparing manner.

by present conditions in portions of California. Mr. Craw reports in a recent letter that the San Jose scale is now exterminated in Santa Clara County, Cal., where it first appeared in this country.

PREDATORY INSECTS WHICH AFFECT THE USEFULNESS OF SCALE-FEEDING COCCINELLIDÆ.

By C. L. Marlatt, *Washington, D. C.*

When the breeding experiments out of doors were commenced with the imported Asiatic ladybird (*Chilocorus similis*), fears were early aroused for the success of the experiment on account of the abundance of predaceous insects[a] in the small grove of pear, plum, and peach trees attached to the insectary of the Department, which it was proposed to use as a breeding ground, inasmuch as it was thickly stocked with San Jose scale.

A great many egg clusters of the wheel bug (*Prionidus cristatus*) and egg masses of our native praying mantis (*Mantis carolina*) were found attached to the trunks and limbs of these trees. Furthermore, a large lot of the egg masses of the European praying mantis (*Mantis religiosa*) had been shipped to us by Mr. Slingerland of Cornell, and these had been placed in an open cage in the midst of this grove, so that the young could escape. The hatching of these egg masses had already begun. Later developments established the fact that both the wheel bug and these two species of praying mantis would feed on the larvæ of Chilocorus and other ladybirds. In addition to this, as the season advanced, the larvæ of the plant-lice-feeding ladybird, *Adalia bipunctata*, were also found to eat the larvæ of Chilocorus when their normal food was not readily available.

The larvæ of the lace-winged fly (*Chrysopa* sp.) preyed more or less upon the Chilocorus larvæ in the breeding cages, eggs of the former insect being deposited on the outside of the wires in bunches in several instances, and the larvæ entering in some numbers. Perhaps some of the parent insects also hatched directly in the cage. A very careful search of the cage had to be made for these Chrysopa larvæ, and a great many of them were destroyed. Comparatively few were found in the grove, and at least they were not numerous enough to occasion any serious alarm.

The chief difficulty in the cage, however, arose from the presence of the *Adalia bipunctata*. This ladybird multiplies with astonishing rapidity, its eggs being laid in masses, and day after day 50 or 100 of its larvæ and pupæ were destroyed in this cage, and it was two or three weeks before a final clearance was effected. The cage tree was a fairly good-sized plum tree, and it seemed almost impossible to dis-

[a] Relating to bird enemies of Chilocorus, I am assured by Messrs. Beal and Judd, experts on the food of birds, that Coccinellids are rarely found in bird stomachs, even in California, where such insects are very abundant.

cover and destroy all of the newly hatched and not very conspicuous Adalia larvæ on the leaves and twigs. The tree was badly infested with plant lice, and these furnished so much food for the Adalia larvæ that very little damage was done to the Chilocorus; but that the former would eat the latter was proved by observation in a few instances, and by inclosing them together in a jar: the smaller larvæ of Chilocorus, our native species, *bivulnerus*, being used for the experiment, were eaten, but nearly grown larvæ—big spiny fellows—were let alone.

The greatest menace to the safety of the Chilocorus larvæ is the wheel bug. It was comparatively easy to keep the outdoor cages free from this predaceous bug, but had no steps been taken to destroy the wheel bugs in the grove the success of the introduction of the Chilocorus would have been very much jeopardized when the time came for their general liberation. These wheel bugs were observed feeding on the larvæ of Adalia and on the larvæ of Chilocorus. They did not feed on the scale insects, the latter being much too small for their notice, and it may be that the almost complete absence of our native Chilocorus in this grove is due to the very great abundance of the wheel bug. When our fears relative to the wheel bug were fully aroused, Mr. Kotinsky, of the Entomological Office, spent a day going through this little grove, destroying egg masses and killing the wheel bugs that had already hatched. He estimated that he killed 9,000 wheel bugs in this grove of not less than one-eighth of an acre, and subsequent results indicated that even with that number destroyed a good many had escaped, and several later inspections had to be made to fairly free the trees. This wheel bug has become extraordinarily abundant in the vicinity of Washington in the last few years, and has been increasing in numbers very considerably in its northern range, which has already been pushed as far as New York and New England.

All the egg masses of our native Mantis that could be found were collected and destroyed. Hatching, however, had already begun. The egg masses of the European Mantis were taken indoors and kept inclosed, and those that had not already hatched were allowed to come out and devour each other until the final extermination was effected by this natural means. The hatched and escaped mantides are with difficulty detected; they are of a dull grayish color, harmonizing with the bark and leaves, and their quick movements and their habit of keeping out of sight under leaves or running around to the other side of twigs when approached render their discovery difficult. All that were found in the grove, however, were destroyed.

Of the five insects mentioned above, four are dangerous enemies of the larvæ of the scale-feeding ladybirds; and, in proportion to their numbers, the benefits from such ladybirds will be decreased.[a]

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[a] A single instance was noted by Mr. Kotinsky, in late July, of the feeding of a larva of a Telephorus on a Chilocorus larva.

The observations and experience of this spring have brought into question the real value, as aids to the fruit grower, of the four predaceous insects mentioned and others of the same class which have general feeding habits. The evidence points very strongly to the conclusion that such insects do more harm by destroying beneficial species like the ladybirds feeding on scale and plant-lice than they will ever do good by eating larvæ or other soft-bodied plant-feeding insects. In other words, the injurious insects which they may feed upon to a greater or less extent are almost without exception species which are very easily controlled by other means, viz, by insecticides or methods of cropping. On the other hand, the beneficial insects which they destroy, as notably the larvæ of ladybirds, which feed on plant-lice and scale insects, include a group of insects of special importance and value to the horticulturist, for the reason that they feed on insects which are not easily controlled by other means, and which, if kept in control by natural enemies, may never require the expensive and, to the plants, dangerous treatment necessary to effect their artificial destruction. As a general proposition, therefore, I am inclined to rank all general-feeding predaceous insects as injurious and distinctly prejudicial to the interests of the horticulturist and farmer. The introduction, therefore, of any such insect, as, for example, the European *Mantis religiosa*, or efforts at their wider dissemination, are mistakes, which, in my opinion, will come to be regretted very keenly in the future. Instead of protecting these insects, I believe it will be much more to the general advantage to destroy all egg masses of mantids and the wheel bug; and to view the lace-winged flies with suspicion, if not to class them as absolute foes.

ADDENDUM.

A very important hymenopterous parasite must be added to the list of natural enemies of the Asiatic ladybird. To our very great disappointment and astonishment, early in September it was found that the pupæ of the last brood were much parasitized, causing a loss of more than 10 per cent of this brood. As many as could be of these parasitized pupæ have been collected, and from them has been reared a little Chalcidid fly, *Syntomosphyrum esuriens* Riley, from five to seven parasites coming from each pupa. This insect belongs with a group of secondary parasites, but no trace of the primary parasite could be found in any of the pupæ examined, although later breeding may develop the primary parasite during the winter or next spring. The larvæ were found free in the abdominal cavity of the Chilocorus pupa, and ultimately all of the substance of the pupa disappears. In one or two cases where parasitism had only just begun to make itself evident, half-grown larvæ were found. These were filled with the yellow fluid contents of the Chrysomelid, and were orange yellow in color. The

older larvæ in the nearly empty shells of the pupæ were whitish in color. That all of these larvæ are of the parasite mentioned above can not be definitely said. Dr. Howard, who examined the material with the writer, is of the belief that the primary parasite will prove to be *Homalotylus obscurus* How., the common coccinellid parasite of this country. If the parasite bred proves to be a true secondary parasite, as believed, its presence in such numbers in the pupæ of Chilocorus is a matter for gratification. If, on the contrary, it be a primary parasite, it seriously threatens the success of the imported Chilocorus and all allied ladybirds. The status of this parasite is given in the appended note by Dr. Howard:

All of the Tetrastichinæ known and whose exact host relations have been determined are hyperparasites. *Syntomosphyrum esurus* Riley has never been proved to be either secondary or primary. It is or was a common parasite of *Aletia argillacea* in the cotton fields of the South late in the summer. It issued frequently and in great numbers from old chrysalids left hanging bare upon the cotton stalks. The chrysalids on being opened were found full of this parasite, and no trace of a primary parasite was ever found. Hence this insect was considered in Bulletin 3 of the United States Entomological Commission, and in the Report on Cotton Insects, by J. H. Comstock, published by the Department of Agriculture in 1879, to be a primary parasite. The question as to whether it might not be a secondary parasite was raised by me in the Fourth Report of the United States Entomological Commission. It was reared, as recorded in Bulletin 5 (Technical Series), of this Division, by Dr. A. D. Hopkins, at Morgantown, W. Va., from *Orgyia leucostigma*. It was reared abundantly in 1896, in the late winter and early spring, at Washington, D. C., from the chrysalids of *Hyphantria cunea*. Moreover, it was reared by F. M. Webster, in 1889, on May 3, according to the notes of the Division, from the galls of *Trypeta gibba* Loew on *Ambrosia artemisiæfolia*. But these Trypeta galls, especially late in the season, are apt to contain several different kinds of insects, not only primary parasites, but frequently lepidopterous, coleopterous, and dipterous larvæ, so that the rearing from the gall means nothing at all; the presumption, however, being that the insect came from the Trypeta either as a primary or a secondary parasite.

Summing this evidence all up, we have the insect reared undoubtedly from lepidopterous chrysalids and from coleopterous chrysalids—that is to say, the Coccinellids under consideration—and also possibly from dipterous insects. Unity of habit—that is to say, unity of host relation—is so marked among the Chalcididæ that wherever such a diversity in the apparent hosts occurs it has become my rule to place such parasites as undoubtedly secondary or tertiary parasites. The primary parasites of a given group of insects belong to certain definite groups. Examples are so numerous that they need not be mentioned. In no case in the whole family, to my knowledge, are the parasites of a single genus parasitic upon more than one order of hosts, and in some instances they are confined even to individual families of hosts, and the assumption that a single species of Chalcidid may be reared from Coleoptera, from Lepidoptera, as well as possibly from Diptera, is almost an absurdity. These are the principal reasons upon which I base my belief that *Syntomosphyrum esurus* is a hyperparasite.

After the reading of these papers they were opened for discussion.

Mr. Webster commented on the value of what Mr. Marlatt had accomplished, and felt that the least the Association could do was to

extend to him a vote of thanks. He then made a motion to that effect. Mr. Webster, continuing, stated that it would have been exceedingly interesting if Mr. Marlatt could have gone to Korea, but doubtless this was not possible. The main object, however, was accomplished. He wondered if Mr. Marlatt would not have had as good success with material gathered from Europe instead of Japan and China. He did not consider that there was quite so much danger from our native predaceous insects as Mr. Marlatt had suggested, and called attention to the value of the twice-stabbed ladybird in clearing maple trees badly infested with the common maple Pulvinaria. The occurrence of *Chilocorus similis* in Europe would indicate that it had a variety of host insects, and that it would feed on almost any species of scale. The insect, however, seemed to have acquired a greater taste for the San Jose scale than any other of the scale insects, and he thought that it would gain about the same status of importance and abundance as other native species, but that it would probably be a little more fond of Aspidiotus and Diaspis species than is *C. bivulnerus*. Mr. Webster was very glad that the studies in Japan and China had been made, and thought American entomologists had a great deal to thank Mr. Marlatt for.

Mr. Scott rose to second the motion made by Mr. Webster. He considered this one of the most important attempts in experimental entomology, and thought Mr. Marlatt was to be congratulated as contributing such valuable work along this line.

The president then put the motion, and it was heartily carried.

Mr. Smith stated that Mr. Marlatt's paper had interested him greatly, and he considered that the most important feature of the work was that Mr. Marlatt had shown that China was the native home of the San Jose scale, and that it was there kept in check by native insects. The question had always been, however, whether the enemy which kept it in check in its home would do the same in the eastern United States. He felt satisfied from investigation in California that our native species was there one of the most active enemies of the San Jose scale. He had found there, quite early in the season, that not only had there been a brood of the ladybird larvæ before the scale began to breed, but that eggs were already scattered over the trees for a second brood. He had seen larvæ as well as adults feeding on the dormant scale. He felt quite certain that this was the insect doing most good in keeping the scale in check in that State. Just why the beetle would not breed with us in the East as continuously he was at a loss to explain. He had watched it for several years, and was convinced that it did not have more than two broods a year in New Jersey. He stated that the beetles were eating on his trees at present, but not at the same rate as in California. He had found them on trees that had never been treated as well as on those which had been treated.

He had in his experiment orchard a number of trees that had never been treated, which showed resisting qualities and did well. The scale never increased beyond a certain point, and then practically died off. He had never found any wheel bugs in this orchard, so that these could not be considered in accounting for the disappearance of the ladybirds. They should hardly rank as enemies, but might form an important factor in the destruction of the larvæ of this ladybird beetle if it really appeared in considerable numbers. He knew that many of our predaceous insects eat a great variety of food. The wheel bug will eat a webworm, the larvæ of the elm-leaf beetle, or anything else in its way with equal pleasure.

Mr. Smith had been able to determine positively that the larva of the two-spotted ladybird eats the young crawling scale larvæ. He thought, as a result of his observations in California, that there was a possibility that the California species of Chilocorus was different from our Eastern form, though they were quite similar in appearance. He had had a number in the early stages and could not make out any difference between them. One year 200 California specimens had been sent to him, and in comparison with the Japanese specimens and those from the eastern United States he was not able to tell which came from one place and which came from the other. To secure the lot that had been imported from Japan, he wrote to every entomologist in that country whose address could be secured. Individual letters were sent, with offers to pay all expenses, and in this way a considerable number of two species were secured, one a large form, the name of which was not remembered at that moment, and the other a smaller species, *Chilocorus similis*. These beetles were taken to a very scaly orchard and liberated on the trees at a season of the year when all stages of the scale were present, and when there was an abundance of time for the beetles to deposit eggs. So far as he knew there had been no survivors. He had not been able to find any larvæ and had not recognized the difference between those of the twice-stabbed ladybird and those of the *Chilocorus similis* until Mr. Marlatt had pointed it out in his paper. He considered that Mr. Marlatt was very conservative in his claims in regard to the imported beetles and thought his suggestions well worth the trial. He was in doubt as to the importance of the injury resulting from the wheel bug, but stated that this species did considerable good in controlling the fall webworm. In response to a query, Mr. Smith stated that the *Chilocorus similis* had been placed in the orchards referred to three or four years ago. He further stated that the orchard had been pretty well cleaned of scales by other means, but that he had never seen any descendants of the imported insects.

Mr. Sanderson observed that *C. bivulnerus* was very common in Delaware and that he knew of several orchards where it kept the

Forbes scale in check. The Forbes scale would sometimes become quite injurious and peach trees would often be killed. It was his observation that the *C. bivulnerus* was largely instrumental in controlling this species, and while he had observed the wheel bug to be very common, yet he had never noticed that it fed on the larva of this beetle.

Mr. Felt stated that he desired to congratulate Mr. Marlatt on his efforts in searching for the native home of the San Jose scale and procuring its natural enemies. He stated that there were no wheel bugs in New York State, so that this insect could not have a hand in destroying parasites. He stated that there were very few of the *C. bivulnerus*. So far as his observations went, he considered the ladybirds most valuable as enemies of plant-lice. Plant-lice were very abundant in Albany in 1897, and ladybird larvæ were so very numerous as to attract considerable attention.

Mr. Hopkins remarked that there was great difficulty in determining the different species of closely related scolytid beetles, and suggested the importance of a close study of closely related species in all stages to definitely determine their distinctness. As an example, two scolytids had been described from Germany as different species, but were afterwards considered the same. After a close study, however, he had found that the two European species belonged to two quite distinct genera. On close study he had found striking differences, not only in habits, but in structure.

The next paper was presented by Mr. Quaintance.

ON THE FEEDING HABITS OF ADULTS OF THE PERIODICAL CICADA.

(*Cicada septendecim* L.).

By A. L. Quaintance, *College Park, Md.*

But little accurate observation seems to have been made on the feeding habits of the adults of the periodical cicada, or so-called seventeen-year locusts. A review of the rather scant literature on the subject indicates also that considerable diversity of opinion prevails among entomologists and others as to the extent to which they feed, and, on the whole, the opinion probably prevails at the present time that the adults, particularly the males, feed but little, if at all, during their brief aerial life of about thirty days. The first note in reference to this point which I have seen is by Messrs. Walsh and Riley, in the American Entomologist, Vol. I, p. 67 (1868). It is here stated, under a general discussion relative to the sting of the periodical cicada, that "the beak is an organ which both sexes of the cicada possess, and by which they take their nourishment. We have

ourselves seen them insert it into and extract it from the branches of different trees, and know that the operation is quite rapid and that the instrument is quite sharp and strong." The same statement was repeated by Professor Riley seventeen years later.[a] Professor Riley also adds a note in reference to an experience of Mr. Gustavus Pauls, in which an apricot tree was so severely injured by the puncture of their beaks in the course of feeding that he took from the tree a gallon of coagulated sap; and he attributes the death of some of his trees to this cause. In the course of his observations on the seventeen-year locusts on Staten Island in 1894,[b] Mr. W. T. Davis says: "The black birch and sweet gum were also great favorites, both as depositories for the eggs and also from which to draw sustenance. It was no uncommon matter to see rows of cicadas along the branches of the sweet gum, each insect with its proboscis stuck into the bark." He also adds, speaking of sumach (*Rhus glabra*): "Though the cicadas were fond of sucking the sap of this bush, yet they rarely tried laying eggs in its tissues."

According to Dr. J. B. Smith,[c] "very little injury is done in feeding, the food consisting of sap of trees of many kinds." Dr. A. D. Hopkins[d] states that the adult cicadas feed but little, if at all.

In our latest and most authoritative report on this interesting species, Bulletin No. 14, new series, Division of Entomology, United States Department of Agriculture, by Mr. C. L. Marlatt, it is stated, doubtless after due consideration of all the evidence bearing on the subject, under the caption "Food habits of the adult insects," p. 72, that "the taking of food in the adult stage seems to be of rare occurrence, and has been observed and commented on by a few of the entomologists who have studied the species. That the periodical cicada feeds at all has even been questioned, and it is quite possible that in some of the cases where it was supposed to have been feeding, the action of the insect was misinterpreted. Such feeding is limited, at any rate, to the female, as in this sex only do we find a perfect digestive apparatus, that of the male being rudimentary."

My attention was called to this question during the height of the abundance of the present brood by the receipt of a letter from a correspondent to the effect that the cicadas were feeding on his orchard trees, and desiring a remedy. After writing him to the effect that he was doubtless mistaken in his observations, as the cicadas fed but little, if at all, in the adult stage, a visit the following day to a near by orchard of three or four-year-old apple and pear trees showed that

[a] Bulletin 8 (o. s.), Div. Ent., U. S. Dept. Agric., p. 14.

[b] Nat. Science Association of Staten Island, Vol. IV, No. 9, September, 1894, pp. 33–35.

[c] Bulletin 95, New Jersey Agricultural Experiment Station, p. 5.

[d] West Virginia Expt. Sta. Bul. 50, p. 9, and Bul. 68, p. 265.

the insects were there in great numbers and were feeding quite generally. On practically every tree both sexes were to be observed, ranging in numbers from 10 to 40, with their beaks stuck straight down against the bark, to all appearances feeding after the usual manner of homopterous insects. In numerous instances the insects were observed, when disturbed, extracting the thread-like setæ from the plant tissue. The insect occurred most usually, in this young pear and apple orchard, along the trunks and larger limbs, which, early in the morning and rather late in the evening, were frequently quite wet with sap which had exuded from the punctures made by the setæ of the cicadas. This exudation of sap was frequently noticed to immediately follow the withdrawal of the sucking apparatus of the insects to such an extent as to run down the trunk a distance of 4 or 5 inches, and the loss of sap in this way and that taken up by the insects would apparently be a considerable drain on the vitality of the plant.

Since the date of making the above observation at College Park on June 5, I have paid special attention to the feeding habits of the cicadas in other parts of Maryland, where my work has taken me, and without exception, in every place visited throughout the range of the insect, both sexes have been observed to be feeding in greater or less abundance. At Hancock, in Washington County, the cicadas were very numerous in a young apple orchard, from 6 to 18 being noted on the several trees closely examined. At Annapolis Junction, in an orchard of two-year-old peach trees, the insects were exceedingly abundant, both feeding and ovipositing. On one undersized tree in this orchard twenty-four cicadas were counted, each with its beak stuck straight down against the bark, and the tree was quite wet along the larger limbs and trunk by the sap exuded from the punctures made. In large oak, maple, and probably other trees, the insects feed very generally in the higher parts of the tree on the more tender branches and limbs. I have been able to establish this by numerous observations with an opera glass from the higher windows of the several college buildings, which are surrounded with large trees of doubtless the original forest growth. This habit of feeding in the higher parts of forest trees will doubtless account to some extent for the opinion that but little, if any, feeding is done, since here there would ordinarily be but little chance of observation. While no attempt was made to determine the various plants used as food, the cicada was observed feeding on the following: Apple, pear, peach, Japan plum, maples and oaks of several species, Carolina poplar, elm, hickory, and *Ilex opaca*.

To determine more definitely the extent to which the beak and setæ of the cicada were inserted into the tissues of the food plants, many beaks were snipped off, by the use of a fine pair of scissors as close to

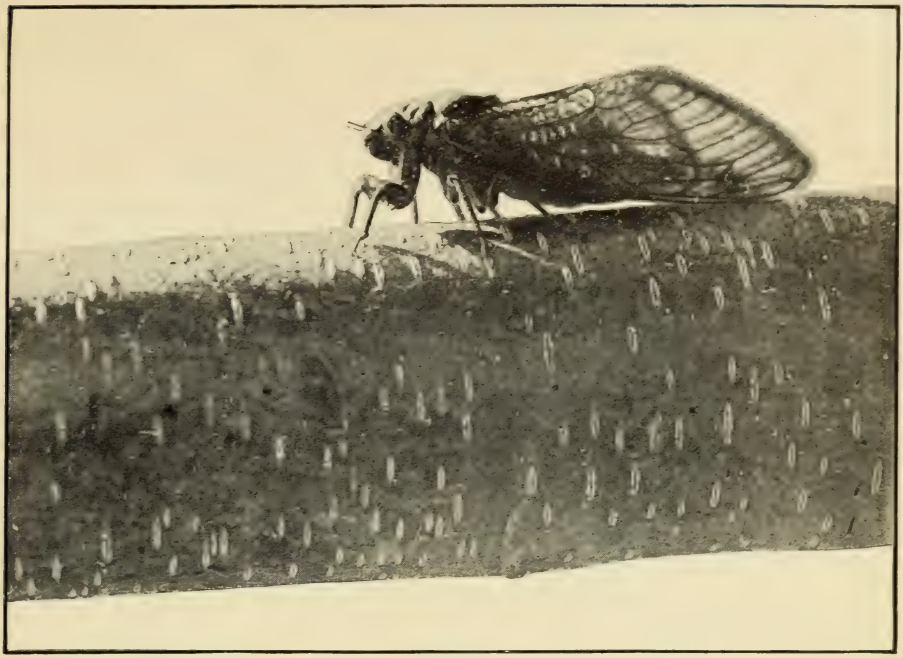

FIG. 1.—CICADA IN THE ACT OF FEEDING.

About twice natural size.

FIG. 2.—BEAK AND SETÆ OF MALE PERIODICAL CICADA IN WOOD OF CAROLINA POPLAR.

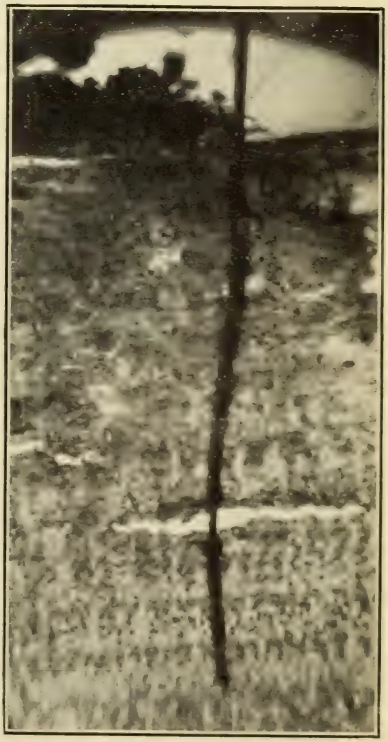

FIG. 3.—SETÆ OF FEMALE PERIODICAL CICADA IN APPLE TISSUE.

Much enlarged—original.

their origin as possible, while the insects were in the act of feeding. A block of wood containing the setæ was cut from the tree and sectioned with the microtome (Plate I). The accompanying photomicrograph illustration shows a section thus prepared with the beak and setæ inserted. The beak, in this case, was taken from a male feeding on the Carolina poplar. Many sections have been made, and show no appreciable points of difference from the one illustrated. It will be noted in the illustration that the sheath penetrated somewhat into the bark, but is not pushed into the harder wood. In all specimens examined, this seems to be true, the beak being pushed only slightly into the outer bark, while the setæ are thrust to variable depths into the cells of the plant.

Despite this evidence as to the fact that the adult cicadas feed, which in the case of almost any other insect would have been convincing, doubt has recently been expressed as to whether it could be considered true that the cicada feeds in the sense of taking nourishment. The use of the mouth parts as above illustrated was considered to be the result more of hereditary instinct than anything else, and, while it was admitted that the beak might be thrust into the tissues, this was considered to be simply a sampling or tasting of the juices of the plant on the part of the insect. At various times, but particularly rather late in the evening, both sexes of cicadas have been taken from trees in the act of feeding, and quickly opened, so as to expose the stomach, or so-called crop, and this has been found in many instances to be distended several times its usual size with the sap taken from the trees.

According to Marlatt (l. c.) the alimentary tract of the male is considered to be rudimentary, and no food is taken by this sex. As shown in the foregoing, males have been observed many times in the act of feeding, and the photograph to which attention has been called shows the setæ of a male in the tissues of the plant. Males, as well as females, have been taken in the act of feeding, and their stomachs found distended with sap. Furthermore, dissections of the alimentary tract of the male shows that it is not rudimentary, but apparently normally developed for this group of insects. The intestine, while small, is continuous to the anus, and is reasonably large for insects subsisting on liquid food. The œsophagus and salivary glands are well developed, while the stomach and crop is rather large and capable of considerable distention.

The setæ are long and tubular and much coiled with the intestine, all being more or less bound together with tracheal threads, so that dissection is rendered somewhat difficult. On the whole the alimentary canal of the male seems to be as fully developed as that of the female. It may be mentioned as a point of importance in this connection that both sexes void quantities of fluid excrement from the

anus, as I have frequently observed, and which is very noticeable on the lower foliage and on the ground, under trees inhabited in some numbers by the cicadas. This discharge of fluid could not reasonably go on without the insect's taking food from time to time.

From the evidence in hand I am led to believe that both sexes of the periodical cicada normally take food in the usual sense of the word, and that in the case of young orchard trees, at least adjacent to woods, where the insects are likely to be abundant, injury may result to the plants attacked.

In discussing this paper Mr. Marlatt said that he wished to congratulate the author on having presented the first really thorough and careful observations which had ever been made on the feeding habits of the periodical cicada. Referring to the published statements in his Bulletin No. 14 on the feeding habits of these insects, he said that at the time this bulletin was written it was impossible to make field observations, and that most of the statements relating to food habits were drawn from general literature on the subject, but they included the reported observations of some of the best entomologists which this country has had, namely, Walsh, Riley, and Smith. In his own personal observations he had never noticed the cicada giving any special evidence of feeding. He was very glad that Mr. Quaintance had gone into the matter so fully, and felt convinced that it had been demonstrated that the cicada does normally and frequently, but perhaps not invariably, take liquid nourishment from trees and plants.

Mr. Smith thought that Mr. Marlatt was justified in his statements, and it was his opinion before hearing this paper that the digestive system of adults of the periodical cicada was rudimentary and not adapted to carrying off food stuffs. He had observed it feeding and had some twigs punctured for feeding purposes, but had often examined the digestive organs of both sexes and came to the conclusion that the cicada did not feed as a rule. Most of his examinations, however, had been made on specimens that had been dead for some time, and it was probable that the digestive organs had quite collapsed.

Mr. Quaintance stated that the intestine of the cicada was very small and thread like and was closely attached to the inner surface of the dorsum of the abdomen of the insect, and unless the dissections were carefully made, and under water, it would be readily overlooked.

Mr. Marlatt, in further discussion of the food of cicadas, said they fed quite industriously during the warm season of each of their seventeen years of underground life, and that it was, therefore, not unreasonable to suppose, in the absence of direct evidence to the contrary, that for the short period of their aerial life the nourishment previously gained would suffice, and hence the feeding in the adult stage might reasonably have been supposed to be a matter of chance. In his own obser-

vations he had never noticed the cicada feeding, and he thought it still open to question whether it was always necessary for the adult cicada to take food. That they did take food Mr. Quaintance had clearly shown. He doubted very much, however, whether the puncturing which they did to trees and the small amount of sap taken caused any special damage to the plant attacked. As an argument for the necessity of feeding of the periodical cicada might be mentioned the fact that when kept in confinement for a few days without food they invariably die.

Mr. Hopkins called attention in this connection to certain insects that can live a long time without food. Both the larvæ and adults of a clerid beetle, collected by him in Germany, had lived several months without food in little vials.

Mr. Quaintance queried if the feeding habits of adult cicadas might not possibly vary with different broods. He asked for information as to the relative abundance of the dwarf (*cassini*) variety.

Mr. Marlatt replied that he had had at different periods opportunity of witnessing three broods of the periodical cicada. In the first two of these he had failed to notice any of the smaller form, all of the specimens being of the normal large size. The present year fully 50 per cent of the early appearing individuals were of the small form. He had been informed also by Professor Galloway, who had made a trip through the West to St. Louis during the cicada prevalence, that the woods were filled with the deafening noise of a cicada, the song being entirely different from the ordinary one. From Professor Galloway's description the small cicada was undoubtedly the one heard, indicating its general abundance this year throughout the range of the brood.

Mr. Hopkins stated that in 1897 the small variety was very abundant in West Virginia, and that it came later than the others.

Mr. Quaintance remarked that the small form came after the large form had disappeared to a considerable extent in Washington County, Md.

The meeting then adjourned to reassemble at 2 p. m.

AFTERNOON SESSION, SATURDAY, JUNE 28, 1902.

The meeting was called to order by the president, who called for the report of the committee on membership. The committee reported as follows:

REPORT OF COMMITTEE ON MEMBERSHIP.

Your committee to consider the question of membership would report as follows:

We recommend the adoption of a by-law to the effect that it be the duty of the officers of the Association, each year previous to the annual meeting, to carefully examine the list of members and recommend to the Association the dropping of such

names as have in their opinion no further place upon our roll; such recommendations to be acted upon by the Association, and a vote of two-thirds of the members present to be sufficient to drop any name.

That in the interpretation of the paragraph of the constitution regarding the election of new members it be understood that an "economic entomologist" is a person who has been trained in entomological work and whose known work or published papers show him to be capable of conducting original work in economic entomology.

That the term "practical entomologist," referring to associate members, be held to indicate persons who have done general work in entomology and who have, by published papers or otherwise, given evidence of their attainments in such work.

That associate members be listed separately in the published roll or the fact that they are associate members be indicated in the list.

HERBERT OSBORN, *Chairman.*
JOHN B. SMITH.
E. P. FELT.

This report was unanimously adopted; and the report of the committee on resolutions was then read and adopted, as follows:

REPORT OF COMMITTEE ON RESOLUTIONS.

Whereas, the effect upon fruit trees of oil sprays for the San Jose scale has been very diverse in different States, and a study of the chemical composition of the petroleum oils used and their physiological effect upon fruit trees seems desirable: Therefore, be it

Resolved by the Association of Economic Entomologists, That the attention of the honorable Secretary of Agriculture be called to the desirability of the Department's undertaking a joint chemical, entomological, and physiological study of the problems involved.

Resolved, That we appreciate most fully the past favors of the Department of Agriculture in publishing the proceedings of this Association, and respectfully request that the proceedings of the present meeting be published as heretofore.

Resolved, That the thanks of the Association be tendered to Dr. W. J. Holland, and to the citizens of Pittsburg, whose favors have rendered the comforts and pleasures of the members in attendance at this meeting a feature to be remembered.

Resolved, That this Association has listened with great interest to the report of Mr. C. L. Marlatt's explorations in Japan and China to study the San Jose scale and its natural enemies, undertaken largely at his own expense; that we feel that the subject of applied entomology in America has been greatly developed and advanced thereby, and that we as an Association hereby tender to Mr. Marlatt our thanks for his generous and unselfish labors.

Respectfully submitted.

F. M. WEBSTER, *Chairman.*
HERBERT OSBORN.
W. E. RUMSEY.

REPORT OF COMMITTEE ON NOMINATIONS.

The committee on nomination of officers for the coming year reported as follows:

Dr. E. P. Felt, Albany, N. Y., president.
Mr. Wm. H. Ashmead, Washington, D. C., first vice-president.
Prof. Lawrence Bruner, Lincoln, Nebr., second vice-president.
Prof. A. L. Quaintance, College Park, Md., secretary and treasurer.

The report of the committee was unanimously accepted, and the secretary was instructed to cast the ballot for the Association.

The secretary presented the name of Mr. E. G. Titus as a candidate for membership in the Association. This name was proposed by Mr. Webster, who explained somewhat at length the training which Mr. Titus had had, the work he had done and his eligibility to membership. After some discussion by members Mr. Titus was elected to active membership.

There being no further business before the Association, the regular program was resumed:

NOTES FROM DELAWARE.

E. Dwight Sanderson, *Newark, Del.*

At the last meeting of the entomological section of the Association of Agricultural Colleges and Experiment Stations the writer described the differences between the more common species of aphis affecting the apple and pear, and a further report concerning them will be found in the 13th report of the Delaware Agricultural Experiment Station, now in press. Our most common species, usually written *Aphis mali* Fitch, is entirely distinct from *A. mali* of Fabricius, which is a synonym of *A. pomi* De G., and the name *A. mali* must therefore be abandoned. I have consequently described Fitch's species as *Aphis fitchii* n. sp., in recognition of his very careful description of it. This name must be regarded as somewhat tentative, however, as Prof. Slingerland is of the opinion that *Aphis avenæ* Oestlund will probably prove to be the same species, in which case it would have priority, and there are certain European species which further study may show to be identical. Meantime the name *fitchii* will clearly designate the species discussed, and the confusion formerly existing will be obviated. This spring I again attempted to breed this aphid in the insectary upon wheat and various grasses, but seemed to fail entirely, none being observed to reproduce on them, either when inclosed in glass cylinders or when free. I also carefully examined a number of wheat fields and various pieces of grass at the time the aphides were migrating from the apples without finding them on the grass. Having found no aphides on the grasses in the insectary up to June 1, they were not examined again until June 25, when I found one of them well covered with an elongate yellowish-white aphis which had caused the leaves to wilt and become streaked with white. These aphides were decidedly elongate, with cornicles and cauda concolorous with body, cornicles tipped with black, antennæ and eyes black, and sometimes with a greenish and sometimes a reddish splotch at the bases of the cornicles, but usually without such marking. A few pupæ were observed but no winged females. It is possible that this may be the same species as the spring form on the apple, as it has certain "ear

marks," though in general it is entirely dissimilar. Should it prove to be the same, there must be a very enormous and decidedly remarkable mortality of the winged females migrating from the apple in May, for which there seems no good reason.

Aphis pomi DeG. seems more abundant than usual this year and becoming more widely distributed. It is unquestionably one of the worst insect pests of the young apple orchard and of old trees being top-worked, and how best to combat it is somewhat of a problem. It should be noted that some varieties of apples are decidedly preferred to others by the aphides, trees of another variety next to badly infested trees often remaining unmolested. Very frequently this season I have found colonies of this species of a bright orange-yellow color instead of the typical bright green, and also intermixed with the green forms. This striking variation has not been previously observed so far as recorded, and I regret that I have been unable to ascertain whether the yellow aphides reproduce the yellow form.

Owing to the manner in which they curl the leaves, *Aphis sorbi* and *pomi* are exceedingly difficult to combat; *Aphis fitchii* rarely does sufficient damage to warrant treatment. Washes of whale-oil soap, 2 pounds to a gallon of water, and lye 6 pounds to 50 gallons have both failed to destroy the eggs. Prof. Aldrich reports having killed the eggs with 33 per cent crude petroleum with water, using a heavy western oil of .954 specific gravity. We have sprayed several young trees with pure crude petroleum ("insecticide oil"), and though there seemed to be fewer young aphides on these trees, there were enough to soon stock the tree with lice. It seemed probable that the gummy residue left upon the surface of the bark was fatal to many of the newly hatched lice, as the crude oil had undoubtedly had a beneficial effect.

Fifteen per cent kerosene mixed with either water or Bordeaux mixture has not proven very satisfactory for destroying the aphides; 20 per cent kerosene seems more effectual and fairly satisfactory; 15 or 20 per cent crude petroleum is quite effectual and does no injury to the trees. When mixed with Bordeaux mixture it tends to make the latter collect in drops, and this is therefore an undesirable combination. Kerosene mixed with Bordeaux mixture and Paris green gives as even a coat upon the foliage as without the kerosene, and would seemingly form a perfect insecticide and fungicide where it can be used to advantage.

I am inclined to the view that in many cases the kerosene sprays are not effectual owing to the improper working of the pump. Kerosene emulsion made with soap and diluted to contain 15 per cent kerosene has failed to destroy the lice. Whale-oil soap, 1 pound to 6 and 8 gallons of water was ineffectual, though 1 pound to 7 gallons was fairly satisfactory. The latter is rather too strong, however, to use

on tender foliage. Rose-leaf insecticide, an extract of tobacco, one part to from 25 to 40 parts of water, is the most satisfactory spray we have used against these aphides. It is, however, most disagreeable to apply and rather too expensive for extensive use. Undoubtedly tobacco water made by boiling 1 pound of refuse tobacco in 1 gallon of water, with an equal amount of water added, will prove to be a good remedy, though we have been unable to give it a thorough trial.

The most satisfactory method of destroying these aphides on young trees is by fumigation. In 1899 we made several tests in fumigating them with hydrocyanic acid gas and found that they could be readily destroyed in ten or fifteen minutes. This spring we had a fumigator of the Geneva type constructed, covering it with strong muslin, which was thoroughly painted with thin glue, and it proved entirely satisfactory. This frame contained exactly 200 cubic feet. The aphides were entirely destroyed by burning 2 ounces of tobacco leaves and fumigating for fifteen minutes; also with one-half a roll of "aphis punk" for twenty minutes. A larger amount of the latter would probably be as effectual in a shorter time. "Aphis punk" is simply paper dipped in a tobacco extract, and is in a handy form to use, though rather expensive. Nikoteen and Nicoticide, both concentrated extracts of tobacco, were used very successfully by diluting with water and evaporating in shallow pans over an alcohol lamp furnished by the manufacturers. One and one-half cubic centimeters of Nikoteen diluted to 15 cubic centimeters with water killed the aphides in fifteen minutes, as did 4 cubic centimeters diluted to 15 cubic centimeters in eleven minutes. It requires about five minutes for the Nikoteen to evaporate. Five cubic centimeters of the Nicoticide diluted with 5 cubic centimeters water killed the aphides in ten and twelve minutes. The Nicoticide "is a very strong solution containing 40 per cent of nicotine" (quoted from a letter of manufacturers): it is a thinner and more volatile liquid than Nikoteen or Rose Leaf, evaporating over the lamp in about three minutes, and seems to be more rapid in its effect upon the aphides. We are inclined to regard this as the most satisfactory method of fighting these aphides upon young orchards. Usually but a few trees are infested here and there, and as the lice do not spread very much until the trees become overcrowded, by fumigating these few trees the injury can be almost entirely checked, as the fumigation destroys practically every aphid, whereas the best spray can not reach a very large percentage of those protected on the curled leaves.

A plain box or bell tent made of heavy, tight-woven muslin (we found a brand termed "Cast iron," in use by hot-air balloonists, very satisfactory) and painted with glue would be fully as satisfactory for use on small trees, and much cheaper. The materials for a tent should not cost over $2, and the making is a simple matter. With a dozen

of these 2 or 3 men could get over a considerable number of young trees in a day.

The strawberry root-louse (*Aphis forbesi.*)—Various means of destroying the strawberry root-louse upon plants prior to setting have been thoroughly tried. Sixty thousand plants were fumigated in two lots in a nurseryman's fumigation house for thirty and forty minutes with 0.2 gram KCN per cubic foot without injury to the plants, and the lice were killed as far as observed. The plants were laid loose, one or two layers deep, on frames of wire netting. Subsequently 7,000 were fumigated in several lots in a small box containing 10 cubic feet for thirty minutes with 0.2 gram KCN per cubic foot and 0.3 gram KCN for twenty-five minutes without injury to the plants.

From 20 to 75 per cent of plants dipped in whale-oil soap, 1 pound to 6 gallons of water, were killed, as were from 50 to 75 per cent of various lots dipped in kerosene emulsion diluted 10 times. Tobacco water (1 pound of stems boiled in 1 gallon of water, used undiluted) was this year used as a dip by a number of large growers with marked success. The beds of one party who has used it for several years showed its good effect. Plants dipped in Rose Leaf insecticide, 1 part to from 20 to 40 of water, were uninjured and the lice were killed. The main difficulty in fumigating or dipping prior to setting is that growers are desirous of setting early, and as with many insects a few of the eggs do not hatch until unusually late, dipping or fumigating at the time the growers wish to plant does not destroy these. To destroy the eggs we have tried burning over the beds, as the eggs are all upon the leaves as far as observed. By covering with straw or similar material which will make a quick fire and burning over just as the plants commence to grow in the spring, the foliage can be burned off without injury to the crowns and the plants will shoot out again, giving a good foliage by the time it is desired to set them in a new bed, and producing fruit the same as if unburnt, except perhaps being a trifle later. The burning should also be of value against other strawberry insects and diseases.

The codling moth.—In experiments with remedies for the codling moth in 1901 it was found that two bands on a tree caught 15 per cent of the larvæ infesting apples upon 5 trees, the percentage varying from 8 to 25 per cent, varying almost exactly inversely to the effectiveness of the spray used. Numerous larvæ and pupæ were collected from these bands, and it was found that a very large percentage hibernated over winter, there being, therefore, but a partial second brood.

Our chemist has kindly analyzed samples of two lots of arsenite of lime and one of arsenite of soda, made according to the usual formulas, with pure arsenic and boiled by steam, and in each case they contained but three-fourths the supposed amount of arsenious acid. The arsenite of lime was used last year at a strength equivalent to 1

pound of Paris green to 215 gallons of water, with a benefit of but 26 per cent over untreated trees for the whole season. It is believed that arsenites of lime or soda should be used at the rate of 1 pound or 1½ pounds of AS_2O_3 to 160 gallons of water to be effectual, and they are being thoroughly tested at various strengths this year. Paris green, 1 pound to 160 gallons of water, and Disparene, an arsenate of lead, manufactured by Bowker Insecticide Company, 3 pounds to 150 gallons, were also tested upon 5 trees each, with 5 check trees, the dropped and picked apples being counted on all. One spraying of Disparene proved as effectual as two of Paris green. It will be noticed that the benefit derived is not so much in the smaller percentage of wormy picked fruit, though that is marked, as in the very much smaller percentage of wormy fruit dropped, the perfect fruit dropped being approximately the same for all the sprayed and unsprayed trees. With 60 per cent of the apples wormy upon the check trees, a benefit of 87 per cent for the season was secured by spraying twice with Disparene, of 60 per cent by spraying once, and of 61 per cent by spraying twice with Paris green. Of the dropped fruit, that sprayed with Disparene twice showed a benefit of 75 per cent, against 52 per cent with that sprayed with Disparene once and 54 per cent with that sprayed with Paris green twice. Likewise with the picked fruit, Disparene applied twice produced a benefit of 96 per cent, against 66 per cent when applied once and 69 per cent with Paris green applied twice.

The periodical cicada has been present the past month in northern Delaware, but so far as ascertained has not occurred in the two lower counties, and I have been unable to secure any records of its occurrence there in 1885. The pupæ first emerged in numbers on May 22, and continued except on a few cold nights until June 2, the most ascending on May 30. Several dogs and cats have been observed to relish the adult cicadas. The turrets or mounds of the pupæ were observed under pine and spruce trees on several old lawns and in a piece of pine timber burned over about the middle of May. The largest turrets were found under a small outbuilding, the floor of which was about a foot above the ground. Here the turrets completely covered the surface of the soil, reminding one of a house-top view over city chimneys, and were from 3 to 6 inches long.

The cicadas have been most abundant upon the lawns of several old estates around Newark, where in some cases they are more numerous than in 1885. The woods around Newark are now brown from dying twigs, and one or two young peach orchards have been practically ruined. The injury is only local, however, and not serious generally. It was observed that the pupæ upon emerging from the ground were strongly attracted by an acetylene bicycle lamp. On changing its position the pupæ would at once turn toward the light,

often going around a circle. Even their strong instinct for ascending the nearest tree was thus overcome, and in several instances those upon the base of the tree descended toward the light. Though I was unable to make a trial of it, this suggested that a bright light in the center of a sunken pan containing water and kerosene might make an efficient trap upon badly infested lawns.

During the season of 1901 the white-marked tussock moth and fall webworm were unusually injurious and seem to be almost equally so this year. The apple-tree tent caterpillar was more abundant this spring than for many years. Apples have been unusually injured by the plum curculio, eight or ten scars on an apple not being uncommon. Arsenical sprays seem to have no effect whatever in preventing this injury, apples being badly stung in an orchard which has been carefully sprayed for many years. On the same place, however, the fruit of an old cherry tree, which was formerly entirely destroyed by the curculio, is now untouched, owing to its being sprayed with arsenites and Bordeaux mixture.

Crambus caliginosellus continues to be one of our worst pests of young corn. *Systena tæniata* often destroys replanted corn and is our worst pest of newly set tomatoes, one for which we have as yet no very satisfactory remedy.

The strawberry weevil (*Anthonomus signatus*) was excessively injurious this year for the first time since 1898, and cut the early staminate varieties about one-third, and in some instances practically ruined the crop. A remedy for this pest would be of great value to berry growers, but it seems invulnerable to attack.

NOTES FOR THE YEAR IN NEW YORK.

By E. P. Felt, *Albany, N. Y.*

The season has not been marked by any unusual demonstrations by injurious insects, except in the case of a few species which will be noticed briefly.

The grape root-worm, *Fidia viticida* Walsh, has caused a great deal of injury in the Chautauqua grape belt during the last two years. It was estimated last spring that fully 80 acres had been practically destroyed by this insect and that at least 200 acres were more or less infested. Subsequent observations have shown that, in all probability, the infested area must be greatly extended. The insect has been so very injurious during the spring that certain vines which developed leaves in an apparently normal manner began to wilt about the middle of June and by the latter part of the month had died. This was attributed to the grape root-worm. The depredations appear to be more serious upon gravelly than upon heavy clay soil, and some recent experiments would appear to indicate that a considerable number of

the pupæ may be destroyed by plowing the soil away from the vines and back while the insect is in this stage.

The grapevine leaf-hopper, *Typhlocyba comes* var. *vitis*., has been exceedingly abundant and destructive in the Chautauqua grape belt last year and early this spring. It caused a great deal of injury in the fall of 1901, and present conditions are very threatening. This insect is now being investigated by Professor Slingerland of Cornell University.

The apple-tree tent caterpillar, *Clisiocampa americana* Fabr., has been conspicuous by its absence in certain portions of western New York. This is probably due, in some cases at least, to the very heavy snows of the preceding winter, which allowed mice free access to all roadside trees and shrubs, which were very largely girdled by these michievous rodents. It thus happened that the tent caterpillars found very little of their favorite food and undoubtedly many hatching on these unfortunate trees must have perished.

The forest tent caterpillar, *Clisiocampa disstria* Hubn., has been present in comparatively small numbers and its depredations during the last three or four years appear to be on the decrease. It is hoped that this year will see the end, for a time at least, of serious injuries by this pest.

The fall webworm, *Hyphantria cunea* Drury, has appeared in the State unusually early and indications are that it will be more destructive than usual.

OBSERVATIONS ON CERTAIN INSECTS ATTACKING PINE TREES.

By E. P. Felt, *Albany, N. Y.*

The work of several species of Tomicus has been very apparent in the Hudson River Valley during the last two or three years, and at our last meeting the writer placed on record his belief that species belonging to this genus were responsible for the destruction of many white pines in New York State. More extended observations have but strengthened that opinion, and this paper is really a continuation of the one published on pages 63–68 of our last proceedings.

One pine was found which bore no signs of injury, although its branches were sparse, which had been entered in large numbers by *Tomicus calligraphus* Germ. The needles were rather thin August 5, 1901, but practically none were brown, although pitch tubes were very abundant and many small masses of pitch had dropped upon the foliage of surrounding shrubs. At this time most of the beetles were running their primary galleries in the living bark along practically the entire length of the trunk and many eggs were being laid.

The next observation was made September 26, and then two-thirds of the needles were brown and the remainder were changing rapidly.

October 16 practically all the needles were brown and dead. The bark was entirely dead, moist, and its inner layers consisted of little else but decaying borings. Practically all of the living Tomicids had forsaken this tree, though some were found in one near by which had been less severely injured. The limbs were entirely bare of needles early in this spring.

This rapid destruction is also well shown in two other trees of which the writer possesses photographs. These pines had been under general observation for four or five years, and early in 1901 the foliage of the top of one may have been a little thinner than normal. This was noticed in particular August 5, at which time the lower limbs were nice and green, though the upper portion of the tree was then dead. An examination showed that the latter had been attacked by *Tomicus pini* Say. The work of *Tomicus calligraphus* in the living lower portion of the trunk was very evident at this time. *Monohammus confusor* Kirby was also very abundant about this tree. It had evidently bred in considerable numbers in the upper portion of the trunk and then attacked the lower part. The needles had practically all fallen from the upper limbs September 26, and those on the lower were brown and dead. Early in 1902 nothing but bare limbs remained. The companion in misfortune stood close by, and August 5, 1901, bore many pitch tubes above the middle, the work of *Tomicus calligraphus*. September 26 all its needles were browning fast, especially those of the lower limbs, and all were dead October 16. Its condition early in 1902 was the same as that of the trees described above. Both of the last mentioned had been attacked by *Dendroctonus terebrans* Oliv., but in small numbers, and most of the injury was undoubtedly caused by Tomicids.

The destructive work of *Tomicus pini* was further evidenced by a complaint from Jeremiah Day, of Catskill, N. Y., December, 1901, to the effect that 50 young white pines 25 or 30 years old had been killed during the preceding summer, and specimens of bark proved this species to have been the depredator.

The above shows how quickly a tree may die and lose its foliage in the Northern States. The dates given above indicate that a pine may be destroyed in about ten weeks. The rapidity with which such trees yield to the elements is well shown in this photograph, which represents a tree that was probably attacked early in 1900, because September 15, 1900, it was in a dying condition. *Tomicus calligraphus* was present in immense numbers at the base of the trunk and in smaller numbers higher up. *Tomicus pini* was found in the lower middle part of the trunk, in the upper portion, and also on the undersides of the limbs. It was found almost exclusively wherever the bark was too thin for the larger form.

The pines along the Hudson River Valley have suffered severely

from these bark borers, which apparently have been the primary cause of the trouble. The reason for this outbreak is not known, although it possibly may have some connection with the great drought of the preceding years, which may have weakened the pines and rendered them easier victims of their insect enemies.

EGG-LAYING RECORD OF THE PLUM CURCULIO.

(*Conotrachelus nenuphar* Herbst.)

By A. L. Quaintance and Ralph I. Smith, *College Park, Md.*

The accompanying table requires but little in the way of explanation, aside from a statement of conditions under which the work was done.

On the morning of May 13, 1902, a considerable number of curculio were caught from Japan plum trees in the college orchard, by the usual jarring method. At this time egg laying had but just begun, as very few punctures were to be found in the young plums. Ten females were taken in copulation and each placed in a four-ounce bottle. Three or four fresh plums were supplied daily to each insect, and the number of eggs deposited was determined by dissection of punctures in the plums as removed. It was found necessary to examine each puncture carefully, as a considerable number of punctures and crescents were to be found in which no eggs were deposited. The bottles were kept rather loosely corked and bits of filter paper were placed in bottom of bottle to absorb any surplus moisture from the plums.

A review of the table shows that the greatest number of eggs deposited by any one beetle was 436, in the case of No. 5, with 276 as the minimum for No. 1, of practically the same age. It is also to be noted that the egg-laying period lasted for eighty days. The death of beetles Nos. 1, 5, and 9, about August 1, would indicate that females may live approximately twelve months and that the broods would overlap somewhat.

Table showing egg-laying record of the plum curculio (Conotrachelus nenuphar), 1902.

Date.	Curculio—									
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	No. 10.
1902.										
May 14	2	4	0	9	8	7	0	3	8	4
15	0	10	0	3	4	5	0	3	1	10
16	8	6	0	9	12	12	2	10	13	9
17	7	9	0	9	12	9	0	3	10	9
18	6	12	0	9	10	10	3	6	9	13
19	5	12	0	8	9	11	3	7	8	13
20	9	12	0	15	15	10	9	13	16	13
21	15	9	0	17	17	11	8	11	16	13

Table showing egg-laying record of the plum curculio, etc.—Continued.

Date.	Curculio.—									
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	No. 10.
1902.										
May 22	9	12	Male?	15	13	14	9	13	17	No p.
23	9	13	.....	14	11	10	8	8	12	14
24	11	15	.....	17	15	13	12	12	14	14
25	9	15	.....	13	17	5	4	13	18	12
26	8	15	.....	14	18	4	4	12	18	11
27	14	12	.....	12	13	10	0	14	19	15
28	3	5	.....	8	8	6	Died.	4	6	12
29	6	4	.....	6	7	4	.....	7	7	8
30	5	3	.....	6	5	5	.....	3	6	5
31	6	6	.....	8	10	5	.....	(a)	9	10
June 1	7	8	.....	9	11	11	.....	.....	11	14
2	7	9	.....	9	11	10	.....	.....	11	14
3	9	5	.....	13	12	15	.....	.....	11	14
4	0	5	.....	7	8	11	.....	.....	12	12
5	6	0	.....	9	9	7	.....	.....	12	8
6	0	4	.....	6	4	6	.....	.....	6	2
7	4	5	.....	10	7	7	.....	.....	10	5
8	4	5	.....	7	5	7	.....	.....	6	4
9	4	4	.....	8	5	7	.....	.....	7	4
10	2	3	.....	4	7	6	.....	.....	7	1
11	2	1	.....	6	4	4	.....	.....	8	4
12	5	3	.....	2	7	3	.....	.....	8	1
13	5	5	.....	4	6	4	.....	.....	8	3
14	0	2	.....	2	4	5	.....	.....	4	5
15	4	0	.....	6	4	4	.....	.....	4	5
16	4	0	.....	6	3	4	.....	.....	4	5
17	4	0	.....	2	8	3	.....	.....	3	4
18	3	0	.....	2	5	2	.....	.....	3	4
19	2	2	.....	Died.	3	3	.....	.....	3	7
20	2	Died.	.....	.....	3	0	.....	.....	5	4
21	2	.....	.....	.....	4	0	.....	.....	3	3
22	2	.....	.....	.....	3	0	.....	.....	4	2
23	1	.....	.....	.....	3	0	.....	.....	4	2
24	2	.....	.....	.....	4	0	.....	.....	3	3
25	2	.....	.....	.....	2	0	.....	.....	3	0
26	1	.....	.....	.....	1	0	.....	.....	2	0
27	3	.....	.....	.....	0	0	.....	.....	0	1
28	2	.....	.....	.....	2	0	.....	.....	1	0
29	4	.....	.....	.....	5	0	.....	.....	1	3
30	1	.....	.....	.....	2	0	.....	.....	1	4
July 1	1	.....	.....	.....	2	0	.....	.....	2	0
2	2	.....	.....	.....	3	0	.....	.....	2	0
3	1	.....	.....	.....	1	0	.....	.....	0	0
4	1	.....	.....	.....	1	0	.....	.....	2	0
5	1	.....	.....	.....	2	0	.....	.....	2	0
6	1	.....	.....	.....	2	0	.....	.....	0	0
7	0	.....	.....	.....	0	0	.....	.....	1	0
8	0	.....	.....	.....	0	0	.....	.....	1	0
9	0	.....	.....	.....	0	0	.....	.....	0	0
10	0	.....	.....	.....	0	Died.	.....	.....	0	0
11	0	.....	.....	.....	0	.....	.....	.....	0	0
12	1	.....	.....	.....	1	.....	.....	.....	0	0
13	1	.....	.....	.....	2	.....	.....	.....	0	1

a Escaped.

Table showing egg-laying record of the plum curculio, etc.—Continued.

Date.	Curculio—									
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	No. 10.
1902.										
July 14	1				2				0	1
15	0				1				0	1
16	1				3				0	3
17	1				2				0	1
18	1				1				1	2
19	1				1				0	1
20	1				4				1	2
21	2				5				2	3
22	3				4				1	1
23	2				4				2	2
24	4				3				1	4
25	3				4				2	4
26	4				5				3	Died.
27	3				5				1	
28	3				5				1	
29	2				4				0	
30	2				4				0	
31	4				4				Died.	
Aug. 1	3				5					
2	Died.				Died.					
Total	276	235		294	436	270	62	142	396	348

The following papers, which had been sent to the secretary, were read by title:

NOTES FROM NEW MEXICO AND ARIZONA.

By T. D. A. Cockerell, *East Las Vegas, N. Mex.*

Nothing especially remarkable has occurred in the field of economic entomology during the past year or two in this part of the country, but the following records are not without interest.

COCCIDÆ.

Parlatoria blanchardi (Targ.).—Professor Forbes (Johnson, Fumigation Methods, p. 229) has recorded the fumigation of about 400 date-palm suckers infested with Parlatoria. He determined, experimentally, that palms would stand a strong dose, and accordingly treated all those received at Tempe, Ariz., for the date-palm orchard of the Arizona experiment station. In the spring of the present year I inspected all these palms and found that the Parlatoria had been totally destroyed. Of course, there are parts of the palms which can not be examined without pulling them to pieces, but I feel quite sure that the Parlatoria would be in evidence upon the visible parts by this time if any had survived. On one palm I found a small quantity of *Pharnacoccus marlatti*, Ckll., alive and healthy.

Chaitophorus negundinis Thomas, on box-elder, and *C. populicola*, Thomas, on narrow-leafed cottonwood, are common in Las Vegas, N. Mex.

LEPIDOPTERA.

Clisiocampa constricta Stretch.—The larvæ of this species defoliated great numbers of cottonwood at Tempe and Phoenix, Ariz., in March, 1902. They were full fed, spinning up at the end of March, and I noticed that they often wandered 100 yards or more from the trees. It would doubtless be easy to trap them at this time with gunny sacks tied around the trees. I bred several moths, but got no parasites. The larva is quite variable in its markings. I made the following notes at Tempe, March 29:

Larva, wandering, ready to pupate; 38^{mm} long (smaller ones, perhaps males, 27^{mm}); general color the usual light blue-gray, with long, white hairs, those on dorsum about 5^{mm}; a broad black dorsal band, constricted somewhat at the sutures, on each segment bearing many erect, rather short, orange-ferruginous hairs; sides minutely speckled with black; an elongated irregular subdorsal black mark on each side of each segment, its lower edge bordered by a small, pale mark; extreme sides with denser tufts of white hair; under surface black, clouded with gray; abdominal legs pale ferruginous apically; head spotted with black and beset with erect, black hairs. Other specimens have large more or less dumb-bell shaped orange dorsal patches, one on each segment.

COLEOPTERA.

Galerucella decora var. *salicis* Randall (det. Schwarz.), was found May 24, 1902, injuring willow in Gallinas Canyon, New Mexico, at a place called Trout Spring.

Lina scripta Fab., was found this year in Las Vegas, N. Mex., but it is rare and not destructive with us. Probably it has some natural enemy to keep it down.

Anthrenus scrophulariæ Linn. has been abundant this spring on flowers in Las Vegas. The first specimens were found by Miss Florence Mair, on flowers of cultivated Berberis.

Haltica foliacea Lec. (det. Fall), was found at the top of the Las Vegas Range, New Mexico, at about 11,000 feet, at the end of June, 1901. What could be its food plant at this altitude? Epilobium, perhaps.

Chrysobothris mali Horn. (det. Schwarz.), was received from Simmons, Ariz., where it was reported to have killed a two-year-old apple tree. The species was originally found infesting apple trees in California, but it has occurred also on native trees and shrubs (though not bred therefrom) and is presumably native. *See* Fall, Coleop. So. Calif. (1901), p. 117.

Diabrotica 12-punctata Oliv., occurs at Phœnix, Ariz., and is not

replaced by *D. soror* until we reach California. From San Bernardino westward *soror* takes its place completely.

A PARTIAL LIST OF THE COCCIDÆ OF OHIO.

By F. M. Webster and A. F. Burgess, *Wooster, Ohio.*

In connection with the following list a short explanation is not inappropriate. The supervision of the work of nursery and orchard inspection was placed in the hands of Mr. Webster in 1900, and the original intention was to gradually collect as much data as possible while carrying out the work and later to publish a report that would be of service to the people and at the same time contain matter of value to the science of entomology. With the retirement of the board of control and the resignation of Mr. Webster, as well as the placing of the inspection work in the hands of the State board of agriculture, the original project had to be abandoned. But we have thought that the fragments obtained during this time were worth placing on record and whatever of value they might possess made available to other entomologists in Ohio or elsewhere. We do not present this as a complete list of the Coccidæ of Ohio, by any means, but rather as the possible basis for a better one, and which will, beyond a doubt, be the work of others than ourselves.

We are greatly indebted to Mr. George W. King and Prof. T. D. A. Cockerell, who made most of the determinations for us at the expense of much time and labor, and without their aid we should hardly have attempted the list at all. Dr. Howard and his assistants have also aided in the same manner. We have also included such species as were contained in Prof. Herbert Osborn's list, included in his "Remarks on the Hemipterous fauna of Ohio with a preliminary record of species" (Eighth Annual Report of the Ohio State Academy of Science, pp. 60–79, 1900), and also species collected by Professor Osborn's assistant, Mr. J. G. Sanders.

1. *Eriococcus azaleæ* Comst. ..... On *Rhododendron catawbiense*, Wooster, May 29, 1900 (Webster). This shrub was planted on north side of experiment station building, and the insect had withstood winter weather in the open.
2. *Gossyparia ulmi* Geoff. ..... On elm, Columbus, June 4, 1902 (Burgess).
3. *Phenacoccus osborni* J. G. Sanders..... On *Platanus occidentalis*, Columbus (J. G. Sanders).
4. *Phenacoccus aceris* Sign. ..... On maple, New Philadelphia, July 13, 1900; Springfield, Oct. 3, 1901.
5. *Dactylopius citri* Bois. ..... Common in greenhouses.
6. *Dactylopius adonidum* Linn. ..... On roots of plum and Carolina poplar in insectary (C. W. Mally); feeding in insectary on canna, barberry, rose, onion, tobacco, and poplar (Wilmon Newell).
7. *Dactylopius longispinus* Targ. ..... In greenhouses.

8. *Kermes gallifornis* Riley..... On oak, Wooster, Sept. 29 1899 (Wilmon Newell); see also American Naturalist, XV, p. 482, 1881.
9. *Kermes trinotatus* Bogue..... On white oak, Georgesville (J. S. Hine).
10. *Orthezia americana* Walk. (?)..... Georgesville (Fullmer). 8th Rep. Ohio State Academy of Science, p. 71.
11. *Orthezia insignis* Dougl. ..... Wooster; Columbus (Osborn). Common in greenhouses.
12. *Lecaniodiaspis celtidis* Ckll. ..... Sandusky (Osborn). Given in Rep. Ohio State Acad. Sci. Rep., p. 71, as a Lecanium.
13. *Asterolecanium variolosum* Ckll. ..... On *Quercus aurea*, Mentor, Feb. 7, 1900 (Wilmon Newell).
14. *Pulvinaria innumerabilis* Rath. ..... Common and sometimes injuriously abundant on maple; Wooster, July 2, 1901, on elm (Burgess); Shreve, July 5, 1901, on pear (Burgess).[a]
15. *Pulvinaria acericola* W. and R. ..... Cleveland, July 11, 1901, on maple. Columbus (Osborn).
16. *Eulecanium armeniacum* Craw ..... On Spanish chestnut, Painesville, Feb. 5, 1897 (Webster), on plum, Richland, June 28, 1900; on plum, Bowling Green; peach, Mentor (Burgess).
17. *Lecanium caryæ* Fitch..... On American elm, Wooster, June 4, 1902 (R. L. Webster).
18. *Lecanium fletcheri* Ckll. ..... On *Thuja occidentalis*, Columbus, Feb. 27, 1902 (Sanders).
19. *Eulecanium oleæ* Bern. ..... Columbus (Osborn).
20. *Eulecanium cockerelli* Hunter ..... Lakeside, on peach, Dec. 1, 1900, and Shreve, on pear, July, 1901 (Burgess).
21. *Eulecanium fitchii* Sign. ..... On blackberry, Minerva; premises of H. H. Altfather.
22. *Eulecanium canadense* Ckll. ..... On American elm, Wooster, July 2, 1901 (Burgess).
23. *Eulecanium websteri* King ..... On mulberry, southern Ohio (Webster).
24. *Eulecanium tulipiferæ* Cook..... On tulip trees, Wooster (Webster); on tulip trees, Cincinnati (Burgess); on same, Avondale (R. W. Braucher); on tulip tree, Lodi, Aug. 1, 1900; on tulip tree, Painesville, July 17, 1901 (Burgess); Warren, July 10, 1901; Weston, Sept. 19, 1898 (Webster).
25. *Eulecanium magnoliarum* Ckll. ..... On magnolia, Cincinnati (R. W. Braucher), Feb. 19, 1901.
26. *Eulecanium nigrofasciatum* Perg. ..... Wooster, Mar. 26, 1902 (R. L. Webster); Cleveland, Dec. 24, 1899, on Norway maple (Webster); Mansfield; Wellsville, Mar. 21, 1901.
27. *Eulecanium nigrum* var. *depressum* Targ. On California pepper tree, Cleveland, Feb. 6, 1900 (Newell).

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[a] Young, probably of this species, were found on Virginia creeper, at Mentor, Nov. 2, 1901, by J. C. Britton. Immature specimens from maple, resembling a Lecanium but having the antennæ of a Pulvinaria, may, perhaps, prove to be a new species.

28. *Eulecanium persicæ* Fabr. ..... Syracuse (Osborn); Dresden (Webster); Norwalk, May 21, 1900, on nectarine.

29. *Eulecanium quercifex* Fitch..... On oak, College Hill, May 22, 1900 (Webster).

30. *Eulecanium prunastri* Fonsc. ..... On plum, very abundant at Gypsum, 1900 (Webster).[a]

31. *Calymnatus hesperidum* Linn. ..... Wooster, in greenhouses on lemon, fig, cinnamon cassia (Webster); oleander.

32. *Saissetia hemisphæricum* Targ. ..... Wooster, insectary, on chrysanthemum, Sept. 17, 1897 (Webster); on *Pteris* sp? Jan. 1, 1900 (Newell); on *Crytomium balsatum* (Webster); Ashland, Mar. 10, 1897.

33. *Aspidiotus hederæ* var *nerii* Bouché... On yucca, Cleveland, Feb. 6, 1900; Cincinnati, Feb. 13, 1901, on palm; on oleander, Dayton, Aug. 12, 1901 (H. E. Maxwell); Columbus (Osborn).

34. *Aspidiotus juglans-regiæ* Coms. ..... On maple, Kinsey, Aug. 4, 1900 (Hine).

35. *Aspidiotus ostreæformis* Curtis..... On plum, Danbury, Dec. 13, 1900 (Burgess); on snowball, linden, and ornamental maple, Cincinnati, Mar., 1901 (R. W. Braucher); on Carolina poplar, Cleveland, Apr. 4, 1901 (Webster); Massilon, Aug. 2, 1901 (Newell).

36. *Aspidiotus rapax* Comst. ..... On bay tree, greenhouses, Soldiers' Home, Dayton, Aug. 18, 1901 (Burgess).

37. *Aspidiotus perniciosus* Comst. ..... On all kinds of fruit trees except sour cherry; also on currants, gooseberries, strawberries, grapes, raspberry, blackberry, elm, maple (rarely), poplar, willow, catalpa, etc. There are over 125 infested localities known in the State.

38. *Aspidiotus aurantii* Maskell ..... On orange tree, June 30, 1902, Columbus (J. G. Sanders).

39. *Aspidiotus ancylus* Putn. ..... On currant, Bridgeport, 1895 (Webster) Clyde, Jan. 18, 1897; on *Cornus variegatus*, Cleveland, Feb. 7, 1900; on *Clethra alnifolia*, Painesville, July 17, 1900 (Burgess); on Norway maple, Perry, July 19, 1900 (Burgess); on quince, Lakeside, Nov. 15, 1900 (Burgess); on plum, Danbury, Dec. 1, 1900 (Burgess); on maple, New Antioch, Mar. 25, 1901. Occurs also on apple and peach, seldom in injurious numbers, and is general over the State.[b]

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[a] *Eulecanium* species not determinable from material at hand are as follows: On rose, Rumley; on peach, Lakeside (Burgess); on Osage orange, Lakeside (Burgess); on pear (George W. Gill), Columbus; on apple, Mentor (Burgess); on plum, Lakeside (Burgess); on quince, Lakeside. What is likely *E. pyri* Schr. was found at Shreve, July 5, 1901 (Burgess), but this should be verified.

[b] *Aspidiotus perniciosus* and *Mytilaspis ulmi* Linn. have been sent me intermixed on twigs of an unknown shrub, from Sandy Bay, near Hobart, Tasmania, by Mr. Horace Watson.—F. M. W.

40. *Aspidiotus forbesi* Johns. ..... On currant, Mertz, Apr. 12, 1896 (Webster); Frogys, Mar. 9, 1898, on cherry; on apple, Painsville, Aug. 22, 1900, (Burgess); on walnut, (J. C. Britton); Columbus (Osborn); Mentor, Cheshire, and elsewhere throughout the State, on cherry and old apple trees.
41. *Aspidiotus cyanophylli* Sign. ..... On *Pritchardia filifera* in greenhouse, Columbus (J. G. Sanders).
42. *Aspidiotus obscurus* Comst. ..... On oak, Catawba Island (W. H. Owen); on hickory, Danbury, Dec. 20, 1900; Columbus (J. S. Hine).
43. *Aspidiotus comstocki* Johnson ..... On maple, Columbus. See Bull. No. 6, N. S., U. S. Dept. Agr., p. 76 (W. G. Johnson).
44. *Aspidiotus uvæ* Comst. ..... On grapes, Cincinnati, Feb. 15, 1901 (Burgess); Pomeroy, Apr. 15, 1901; also on grape.
45. *Aspidiotus ficus* Ashm. ..... In greenhouses, Wooster (Webster); Columbus, in greenhouses (Osborn).
46. *Aspidiotus glanduliferus* Ckll. ..... On *Pinus sylvestris*, Columbus (J. G. Sanders).
47. *Aspidiotus crawii* Ckll. ..... On *Satania* sp.? McGregor's greenhouses, Springfield, Feb. 15, 1900.
48. *Chrysomphalus dictyospermi* Morg. ..... Columbus (Osborn).
49. *Chrysomphalus aonidum* Linn. ..... Reported from Ohio by Mr. Geo. B. King.
50. *Diaspis pentagona* Targ. ..... Painsville, introduced on double flowering cherry from Japan. Died out during winter of 1898–99 (Webster).
51. *Diaspis cacti* Comst. ..... In greenhouses, Columbus (Osborn).
52. *Diaspis boisduvalii* Sign. ..... On palm, Wooster, station greenhouse (Webster); on *Seafortia* sp.? Cincinnati, Eden Park conservatories, Feb. 19, 1900 (Newell); on palm, Columbus (Hine).
53. *Aulacaspis rosæ* Bouché ..... On rose, raspberry, blackberry, common, Wooster, Columbus, Mentor, New Carlisle, Berlin Crossroads, New Antioch, Perry, Portsmouth, Eaton, Cleveland, Toledo, Xenia, Fruit Hill, Cincinnati.
54. *Aulacaspis bromeliæ* Kerner ..... Columbus (E. E. Bogue).
55. *Parlatoria pergandei* Comst. ..... On Croton, Painsville, Sept. 22, 1900 (Webster); Columbus (Osborn).
56. *Parlatoria zizyphus* Lucas ..... On oranges in market, Columbus (Sanders).
57. *Mytilaspis linearis* Mod. ..... Reported from Ohio by Mr. Geo. B. King.
58. *Mytilaspis pomorum* Bouché ..... Abundant and destructive, especially in the northern parts of the State. Seems to be increasing in abundance and severity of injuries, especially on apple, Carolina and Lombardy poplars, willows, and lilac.
59. *Mytilaspis citricola* Pack. ..... On oranges in the markets. Not known as established in the State, in conservatories, and greenhouses.

60. *Mytilaspis ulmi* Linn. ..... On maple, Dayton, Aug. 19, 1901 (Burgess). Received from Sandy Bay, Tasmania, on apple (Webster).
61. *Chionaspis biclavis* Comst. ..... Columbus (Osborn).
62. *Chionaspis euonymi* Comst. ..... On althea sp? Spring Hill Cemetery, Cincinnati, Feb. 13, 1901 (Burgess).
63. *Chionaspis furfurus* Fitch ..... Generally distributed over Ohio on apple, pear, quince, and currant.
64. *Chionaspis pinifoliæ* Fitch ..... On *Pinus austriaca*, generally over the State where this pine is grown.
65. *Chionaspis corni* Cooley ..... Sandusky (Osborn).
66. *Chionaspis salicis-nigræ* Walsh ..... Not uncommon on willow; Wooster, June 14, 1901 (Burgess); West Carlisle, Oct. 4, 1901, on poplar (Burgess.)
67. *Chionaspis americana* Johns. ..... On *Ulmus americanus*, Columbus, Feb. 28, 1902 (J. G. Sanders).
68. *Chionaspis ortholobis* Comst. ..... On *Gleditschia triacanthos*, Columbus, Jan. 21, 1902 (Sanders).
69. *Howardia biclavis* Comst. ..... On *Hibiscus aculeatus*, Columbus (Sanders).
70. *Kermes andrei* King ..... On *Quercus prinus*, Columbus, May 30, 1902 (J. G. Sanders).
71. *Kermes pubescens* Bogue ..... On *Quercus macrocarpa*, Columbus, June 18, 1902 (J. G. Sanders).

OBSERVATIONS UPON THE MOSQUITO, CONCHYLIASTES MUSICUS.

H. A. Morgan, *Baton Rouge, La.*

Along the creek bottoms of the uplands of Louisiana this mosquito is not uncommon, and in these regions is frequently called the "swamp mosquito," a name which is misleading, for in alluvial marshes and swamps it is seldom seen. The female is fierce in its attack upon mammals frequenting wooded regions in the vicinity of creeks. Marked swellings usually follow the attack upon man.

Nothing has been published relative to the life history of this mosquito. In fact, we are not aware of any observations upon the stages of its development save in the adult.

Dr. J. W. Dupree, of the city of Baton Rouge, captured April 30, 1902, a female which he permitted to feed upon his hand until fully engorged. On the morning of May 1, 40 eggs were found, some at the bottom of the glass containing the water, while others were resting upon some fibers of cotton which had accidentally fallen into the vessel. Dr. Dupree thinks it altogether likely that the eggs, which are deposited singly, under normal conditions rest upon floating débris. The eggs resemble somewhat in shape those of *Stegomyia fasciata*, though larger. Short spines pointing toward the so-called head of the egg are uniformly distributed over the entire shell. The egg has a flat and a convex surface, and with the latter uppermost presents a distinctly fusiform shape. Unless débris or a strong film floats upon the

surface of the water, all the eggs sink to the bottom of the vessel, which accounts no doubt for the irregular periods of incubation. Of the 40 eggs deposited during the night of April 30 a few hatched on May 15, others hatched on May 30, and still others of the same brood on June 10. It will be seen from this that a wide range obtains as to the incubation period (from fifteen to forty days).

The larvæ are active at the surface of the water for the first twenty-four hours, after which they move to the bottom when disturbed, and can there remain as long as forty-seven minutes without coming to

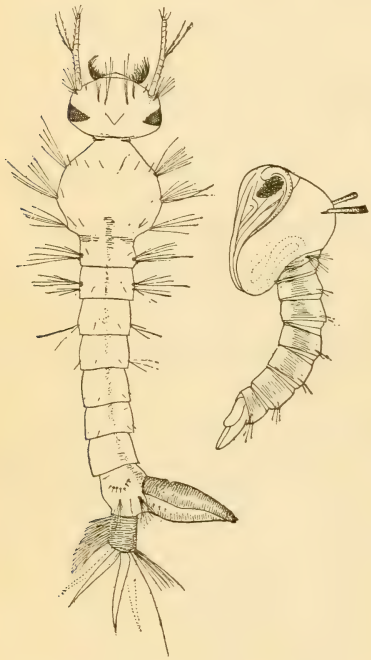

FIG. 1.—*Conchyliastes musicus:* egg, at left; larva, in middle; pupa, at right; all enlarged (drawn in Division of Entomology).

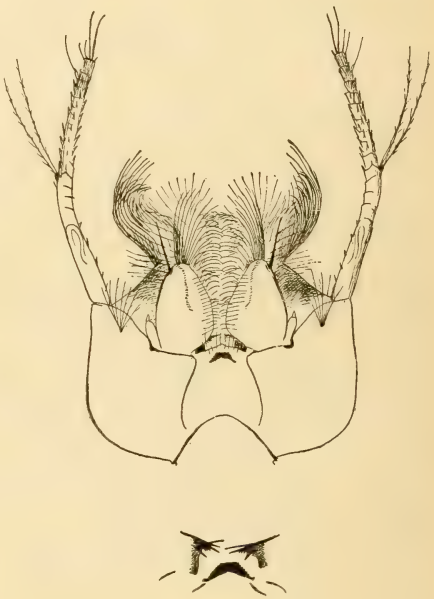

FIG. 2.—*Conchyliastes musicus:* head of larva above; inner mouth-parts of larva below; much enlarged (drawn in Division of Entomology).

the surface for air. Larval growth is very rapid, most of the specimens bred reaching the pupa condition in five days (120 hours), though as long as seven days have been spent in this condition.

The larvæ are not "wigglers" in the true sense of the term. They jerk characteristically when suddenly disturbed, but ordinarily move from the top to the bottom of the vessel at an angle of about 45 degrees with little motion save the rapid movement of the oral cilia. The passing of the larvæ from the top to the bottom of the water with apparently little effort gives them a graceful appearance. While at the bottom of the glass they catch large bundles of Spirogyra, which are broken into smaller pieces as the surface is approached. The vertices

caused by the movement of the oral cilia bring the small pieces of food to the mouth. The pupæ are extremely sensitive, shifting position from the surface of the water with the slightest irritation. Length of pupal stage, twenty-four hours.

The peculiar conditions best suited for the development of this species of mosquito have not yet been found. Females fed in confinement upon the blood of mammals in most cases died in a few days without depositing eggs. Eggs procured in two instances were from females which were engorged with blood a few hours before oviposition.

To Dr. J. W. Dupree is due the credit for the information contained in the above article.

SOME NOTABLE INSECT OCCURRENCES IN OHIO FOR FIRST HALF OF 1902.

By Herbert Osborn, *Columbus, Ohio.*

The season is not far enough advanced to enable us to say what its character as a whole may be from the entomological standpoint, but already there have been several species appearing in such numbers as to attract more than usual attention.

The clover leaf-weevil, *Phytonomus punctatus*, has been unusually plentiful, and during the middle of May the larvæ were to be found in large numbers on the university farm. This is, I believe, the first time that this species has been destructively abundant in this locality. Its work will therefore be watched with interest, and it is to be hoped that it will repeat its usual history of being destructive for but one or two seasons.

The chinch bugs were flying in large numbers during the month of May, being especially conspicuous from the 15th to 20th. This abundance was to be looked for, as they were very plentiful last autumn and the winter was fairly favorable for their hibernation. Some reports of destructive work in wheat have been received, but since the heavy rains of early June these have been fewer, and there is perhaps no very serious outlook at present writing for the remainder of the season.

The cankerworm continues to be a menace to the orchards, and in many a very serious loss has occurred. There are a number of places near Columbus where this insect is defoliating the trees each spring; and while its work is much commented on at the time destruction is in progress, there seems a decided apathy on the part of a good many of the orchardists with regard to suppressing their onslaughts. In a number of places I have noticed their work also on elms, and the increase and spread of the species certainly merit all the attention they have received and a little more of vigorous treatment on the part of owners of orchards and timber plantations.

The horn fly, *Hæmatobia serrata*, has been noticed as very plentiful, perhaps not so abundant as during one or two summers after its first distribution, but in such numbers as to prove a serious annoyance to animals.

The fall webworm, *Hyphantria cunea*, has appeared in very great abundance and, it seems to me, much earlier in the season than usual. One colony was noticed in the latter part of May with larvæ already nearly grown, and during June numerous broods have been observed, some of which at present, June 26, appear to have completed their growth and entered the pupa stage. I have noticed the cuckoo feeding on the larvæ, tearing open the webs in order to get at them.

The occurrence which has doubtless attracted the most general attention and received the most extended popular notice is that of the periodical cicada, the eastern border of the brood passing just east of the city of Columbus.

The first occurrences noted in this locality were May 20, while reports indicated it two or three days earlier at Cincinnati. There seemed to be a fairly well marked early and later wave in appearance separated by a period of about two weeks, a second very abundant occurrence coming in early June. In an old orchard on the university campus this was particularly marked, as the early ones seemed to be completely destroyed by the attacks of the English sparrow so that at one time, about June 1, no individuals could be seen or heard, while the ground was completely littered with the wings and other fragments of the dismembered cicadas. The later appearing forms, while not so completely destroyed at that point, were, I think, mostly destroyed before they had succeeded in laying eggs, and for this particular spot it would appear as if there would be scarcely any to appear in another seventeen years. To some extent this is true of the wooded tracts near the city, but a few miles out I have noticed that the timber is pretty well marked with wilting leaves or drooping twigs which indicate the deposition of eggs.

A very noticeable feature, especially striking to me since I have never encountered it so conspicuously before, is the very large proportion of the small form of the cicada which has been recognized under the name of *cassini*. I have improved the opportunity to secure measurements of a large series, but this forms the subject of another paper and need not be further mentioned here.

An interesting occurrence noted this spring is *Gossyparia ulmi*, not hitherto recorded for Ohio, but found in sufficient numbers to be worthy of mention. As yet it can hardly be counted as of destructive abundance, but, taken with other coccids on the same tree, it must cause some injury.

A Pulvinaria has been observed as quite abundant on elms also, but lack of time has prevented any careful study of it.

Following the reading of these papers, they were opened for discussion.

Mr. Fisher asked how the cankerworm was most successfully treated. He stated that there was a very serious outbreak of the cankerworm in his orchard in Canada and that he had used bands, saturated with a castor oil and resin mixture, around the trees. Several thousand trees had been banded and on these trees, so far as he knew, there had been no cankerworms the present spring. It had required some time to inspect them and some experimentation was necessary before the effective proportion of the ingredients had been determined. It was extremely satisfactory as far as his experience had gone.

Mr. Quaintance inquired what proportion of oil and resin had been used, to which Mr. Fisher replied that 3 pounds of castor oil was used to 5 pounds of resin. The materials were warmed to thoroughly break up the resin, but were applied cold.

Mr. Osborn stated, in reference to the treatment of the cankerworm, that it was the practice to spray the trees with arsenate of lead or Paris green as soon as possible after the larvæ had made their appearance. He stated that at this time the insects were much more susceptible to treatment than later when the larvæ were more nearly full grown.

Mr. Smith stated that Dr. Howard had desired the observation of members in reference to the elm leaf beetle, and in regard to this insect he stated that it was more abundant in New Jersey the present year than for some time past. Four years ago there had been a great scarcity of the insect and two years before this it had not been necessary to do any spraying at all. Last year the insects began to increase to some extent and it was necessary to spray to destroy the larvæ. This year they were in large numbers and it had become necessary to spray while the beetles were feeding. By this means the beetles were largely killed off, but quite a number of larvæ had come through from the egg. In speaking further of shade-tree insects, Mr. Smith stated that the fall webworm promises to be more abundant in New Jersey this year than last. There had been a very great increase of this species the latter part of that year, and trees were considerably injured. The insects were not especially abundant in the early part of the season, but this year they had been destructive already. They had appeared so abundantly at the experiment station that he found it necessary to spray with arsenate of lead, and he thought, from the present condition, there would likely be a great increase of this species throughout the State before the season was out.

Mr. Felt spoke of the increase of this beetle and of the work of the green fruit worm.

Mr. Smith replied that he had not observed the green fruit worm

to occur in New Jersey as a pest, but very early in the spring specimens had been sent him from a greenhouse man in Morris County. There were quite a number of specimens sent, and he had been informed that at various places there was a considerable amount of injury that had been done and was being done by this insect. Mr. Smith said he was much interested in the remarks of Mr. Sanderson concerning the chimney making of the periodical Cicada. He had never seen more perfect specimens than those exhibited by Mr. Sanderson, from Delaware.

Mr. Sanderson explained that these chimneys occurred only under buildings.

Mr. Scott at this point called attention to the coming meeting of the Association of Agricultural Colleges and Experiment Stations to be held in Atlanta, Ga., during October. He extended an invitation to the section of entomology and to the horticultural inspectors who might be present to take part in an excursion over the State, for which it was his desire to arrange.

Mr. Quaintance referred briefly to some of the entomological features in Maryland for the year. Attention was called to the strawberry beetle, which had been very abundant in the strawberry fields in Maryland and had cut off a considerable quantity of the bloom. The growers had estimated that from 35 to 50 per cent of the flowers had thus been cut off. At Greensboro and Ridgely they had adopted planting certain varieties which were very profuse bloomers, and the results were that the effect of the insect was rather beneficial than otherwise, as it tended to thin out the fruit, giving a better size and quality. Another insect that had proven to be somewhat injurious locally was the New York plum weevil. It had been reported by one orchardist as attacking the opening buds in the spring and doing considerable injury. Beetles were confined in breeding cages, and eggs and larvæ of the insect had been secured in considerable quantity. The eggs were deposited on leaves and protected by a fold. They were laid in masses of from 6 to 30. The larvæ inhabit the soil, immediately penetrating beneath as they hatch from the egg. They had been observed to feed on the roots of grass. Another insect that had been locally abundant was a species of grasshopper, *Melanoplus bivittatus*. An outbreak of this species occurred in Washington County, and it had been very injurious to clover. In one large field the clover crop had been largely destroyed. Adjacent to this field was a newly planted apple orchard, and the trees were doing nicely. The cutting of the clover forced the grasshoppers to the apple orchard, and the insects had attacked the trees, chewing the bark. In many cases the trees were entirely stripped of bark. The pea louse, which had been quite injurious in former years, was not now considered of great importance from the fact that growers planted only early varie

ties. The pea louse was not observed to be present in pea fields until after the middle of June. The fall webworm was quite abundant in Maryland this year, and was generally distributed all over the State.

Mr. Burgess stated that the plum curculio had done considerable injury to apples in northern Ohio the present year. The plum crop had also been severely injured.

Mr. Smith stated that there had been considerable injury in the southern part of New Jersey from the strawberry weevil, but it had not made its appearance in the northern part. While the injury had been rather extensive, he questioned if the loss had been of much real importance, owing to the beneficial effect of the thinning of the fruit. In reference to the pea louse, Mr. Smith stated that in the past some of the pea fields suffered quite a good deal, but up to this time in the present season the insects had not appeared in any number. A species of louse has been abundant on clover, but he did not learn of this until after the clover had been cut. He did not know whether or not there was any relation between the insect on clover and the pea louse.

Mr. Sanderson stated that the only information in reference to the occurrence of the pea louse in Delaware that had come to him was from reports, but it was his opinion that the insect had been of but little importance.

Mr. Hopkins inquired of Mr. Quaintance if the early planting of peas had been the result of entomological investigation.

Mr. Quaintance stated that he was not able to say, and referred the question to Mr. Sanderson, who replied that he did not know who had first suggested the plan of planting early varieties of peas to get around the injury from the pea louse. He thought that possibly it had been done by Professor Johnson. Mr. Sanderson stated that early peas both this year and last had been practically free from the insect. The remedy had been brushing, following by a cultivator, and in New Jersey a sprayer had been used.

Mr. Webster stated that the planting of early varieties of peas was the practice followed in Ohio.

Mr. Smith remarked that he had given the advice to plant early as soon as the life history of the insect had been worked out and in his first publication on the subject. In New Jersey he found it was safe to count on practical freedom from the insect until the middle of June.

Mr. Bogue, in speaking of the melon louse, thought that this insect could be readily killed by fumigation. He was much interested in the matter of parasites of this species. In regard to the grapevine-root worm, he thought that possibly the farmers had a remedy in the use of chickens which would help them some. Fowls had been used with good success with other insects. If the beetles were knocked off, he thought the fowls would destroy a great many of them.

Mr. Smith stated in reference to the melon aphis that fumigating with carbon bisulphid was common in New Jersey, and that a number

of growers had a considerable supply of caps or covers for fumigating their vines. A close lookout is kept for the insect early in the season, and they endeavor to destroy the first infestation. Covers to the number of 10, 20, or even 50 were kept going for two or three days, and in this way all early infestation was destroyed.

Mr. Marlatt, referring to the reports on the periodical cicada, stated that the cicada turrets were very rare in Washington this year, and had only been found in a single instance. In this case they occurred in the woodshed of a gentleman living on Washington Heights, on the outskirts of the city. This woodshed had an earthen floor which was slightly moist, but not more so than the ground outside. The cicadas had come up in this shed in great numbers, and in every instance had built a turret varying in height from 1 to 6 inches. Without the shed the cicadas had come up in equal numbers, but through simple holes in the ground, without any sign of a turret. The explanation of the presence of the cicada turrets within this shed would be somewhat difficult. He had suggested that perhaps it was due to the darkness in the shed which led the cicadas to build their galleries above the surface of the soil in the effort to reach broad daylight.

Referring to the elm-leaf beetle, he said that Doctor Howard had already called attention to its practically complete absence in the elm grove on the grounds of the Department of Agriculture this year. This elm grove, he said, had been filled with beetles every year since he had been connected with the Department, and before it became the habit to have it properly sprayed the trees had been regularly defoliated. The complete absence of the insects this year was, therefore, rather remarkable. They were also very rare throughout the city, not doing more than one-tenth the damage of other years.

Mr. Hopkins stated that Doctor Felt's paper on pine insects had interested him, and it was his opinion that the collected beetles had not been the cause of the eradication of the insect the following year. This species is attacked by a parasite, *Bracon strobi*, which reduces it, and he thought probably this should be considered an important factor in their scarcity the following year. In regard to the pine Tomicus, Mr. Hopkins stated as a rule it would not attack perfectly healthy trees. In Germany there were two or three species regarded as injurious to pine forests. They prefer to attack injured trees, especially felled ones. He spoke of the new field of investigation to which he had been assigned with the Department of Agriculture—namely, the study of forest insects—and solicited the cooperation of entomologists of the different States and expressed his own desire to cooperate with the entomologists whenever possible. He considered that there was much room for original observation and thought much good would likely result from cooperative work.

Mr. Webster observed that the use of the term "States" he con-

sidered to be wrong. He thought too much distinction was drawn on State lines. Insects occur all over the country, and he thought life zones or geological boundaries were more proper terms to use. Mr. Webster further stated that refined kerosene had been used extensively in southern Ohio without injury to apple trees, but applied in less quantities in other parts of the State trees had been killed. He spoke of the need of investigation of the effect of mineral oil upon plants. He thought there were factors that were not understood.

Mr. Smith remarked that he agreed with Professor Webster in reference to the word "State," but it served in another way to express the actual facts that different workers had obtained varying results, and was really a designation of a worker in any given State.

Mr. Sanderson called attention to the fact that a record of the weather as made by the Weather Bureau was conducted somewhat along this line. He stated that he had had occasion to look up the weather record, and was able to secure the data from the State bureau.

Mr. Smith stated that in New Jersey there was a tabulated record for every locality at which a station is established, and that he was thus able to secure the weather record for ten or more years back without much trouble.

Mr. Hopkins observed that in West Virginia he had concluded it was not safe to base conclusions on the work of voluntary weather observers. Stations were at different elevations along the line, east and west. He considered the influence of climate as shown by the difference in flowering periods of plants to be of considerable use in this connection.

The president called attention to the matter of a small assessment of the members present to meet the current expenses of the secretary, and on motion it was voted to assess each member 50 cents.

It was voted to hold the next meeting at the same place of meeting of the American Association for the Advancement of Science, namely, Washington, D. C. After some discussion as to the exact date of meeting, it was voted to leave this to the officers of the association, the date to be announced by the secretary in the preliminary notice.

The meeting then adjourned.

CALLED MEETING, SATURDAY, JUNE 28, 1902.

A called meeting of the association was held in the Schenley Hotel, June 28, at 5 p. m., to consider the matter of electing representatives to the council of the American Association for the Advancement of Science, the association being entitled to this representation. Mr. Hopkins moved that two fellows be elected to the council, and a ballot was taken, with the result that Mr. A. D. Hopkins and Mr. C. L. Marlatt were elected.

A. L. QUAINTANCE, *Secretary.*

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Fernald, H. T., Agricultural College, Amherst, Mass.
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Fletcher, James, Central Experimental Farm, Ottawa, Canada.
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CONSTITUTION, ASSOCIATION ECONOMIC ENTOMOLOGISTS.

This association shall be known as the Association of Official Economic Entomologists.

Its objects shall be: (1) To discuss new discoveries, to exchange experiences, and to carefully consider the best methods of work; (2) to give opportunity to individual workers of announcing proposed investigations, so as to bring out suggestions and prevent unnecessary duplication of work; (3) to suggest, when possible, certain lines of investigation upon subjects of general interest; (4) to promote the study and advance the science of entomology.

The membership shall be confined to workers in economic entomology. All economic entomologists employed by the General or State governments or by the State experimental stations, or by any agricultural or horticultural association, and all teachers of economic entomology in educational institutions may become members of the association by transmitting proper credentials to the secretary and by authorizing him to sign their names to this constitution. Other persons engaged in practical work in economic entomology may be elected by a two-thirds vote of the members present at a regular meeting, and shall be termed associate members. Members residing outside of the United States or Canada shall be designated foreign members. Associate and foreign members shall not be entitled to hold office or to vote.

The officers shall consist of a president, two vice-presidents, and a secretary, to be elected annually, who shall perform the duties customarily incumbent upon their respective offices. The president shall not hold office for two consecutive terms.

The annual meeting shall be held at such place and time as may be decided upon by the association at the previous annual meeting. Special meetings may be called by a majority of the officers, or shall be called on the written request of not less than five members. Eight members shall constitute a quorum for the transaction of business.

The mode of publication of the proceedings of the association shall be decided upon by open vote at each annual meeting.

All proposed alterations or amendments to this constitution shall be referred to a select committee of three at any regular meeting, and, after a report from such committee, may be adopted by a two-thirds vote of the members present: *Provided*, That a written notice of the proposed amendment has been sent to every voting member of the association at least one month prior to date of action.

BY-LAWS.

Article I.—*Of members.*

Section 1. The classes of members are defined in the constitution, as are their rights to vote or hold office. Members of all kinds have equal privileges as to presentation of papers and in the scientific discussions at the regular meetings, and may, by permission of the presiding officer, speak on business questions before the association.

Sec. 2. All members have equal rights to the published proceedings of the association and to any publications controlled by or distributed by the association, save that should any publications of economic interest be distributed by the association the distribution lists furnished by the active members are first to be regarded.

ARTICLE II.—*Of officers and their duties.*

SECTION 1. It shall be the duty of the president, in addition to the ordinary duties of a presiding officer, to prepare and deliver an annual address, to be delivered at the annual meeting over which he presides.

SEC. 2. It shall be the duty of the secretary to provide the necessary stationery and such books as he may be directed to provide, the expenses for which shall be met by an assessment of not less than 25 cents on the members in attendance at the meetings. The sum so collected shall be used by the secretary to reimburse himself for advances made and to meet the ordinary expenses of the association. An account shall be rendered at each annual meeting, and, if needed, an additional assessment shall be imposed.

SEC. 3. All officers shall be elected by ballot after open nomination, and this by-law shall not be suspended except by unanimous consent of the voting members present.

ARTICLE III.—*Of meetings.*

SECTION 1. Notice of the time and place of meetings shall be published in all the American entomological periodicals and in Insect Life.

SEC. 2. Special meetings shall be called as provided for in the constitution, and notice of such meetings shall be given by the secretary by mailing to each voting member a formal specification of the time and place of meeting at least two weeks before the date fixed in the notice. The notice shall state the reason for such meeting, and shall specify the business to be transacted, and no other business shall be transacted.

SEC. 3. The order of business at regular meetings shall be, at the first session:

(1) Calling the meeting to order by the president.
(2) The annual address by the president.
(3) Reports of officers.
(4) Reports of committees.
(5) Proposal and election of members.
(6) Written business communications.
(7) Verbal business communications.
(8) New business.
(9) Programme of papers and discussions.
(10) Adjournment.

At the following sessions:

(1) Reading and action on the minutes of previous meetings.
(2) Unfinished business.
(3) Proposal and election of members.
(4) New business.
(5) Programme of papers and discussions.
(6) Adjournment.

At the last session of the meeting the order of business shall be as at other sessions, except that after order (5) will come:

(6) Election of officers for the next meeting.
(7) Fixing time and place of next meeting.
(8) Reading and action on rough minutes of the entire session.
(9) Final adjournment.

ARTICLE IV.—*Amendments to by-laws.*

SECTION 1. Changes in these by-laws may be made at any regular meeting in the same manner and on the same notice as prescribed in the constitution for amendments to that instrument.

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